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Vol. 22, No. 1

EDITORIALS

Food and Fractions

FOR all that has been said about America's unpreparedness, no nation on earth is so well fitted for a fight to the finish.

We may not be ready for a blitzkrieg. No doubt we need thousands of planes and tanks, and the training of millions of men. But no country in the world is so well able to produce the machines and munitions of defense, so well able to spare the man-power for their possible use.

Why? Because war in the ultimate is a fight with food and fractions.

Not only do armies fight on their stomachs, as noted by Napoleon, but the nations behind them must be fed too—and well fed if national morale is to be maintained. America has the acreage and the fertility of farm land to feed soldier and civilian alike all they can eat, and still have a staggering surplus for the wastes and destruction of war.

But what about the fractions?

The nation best prepared for war is the nation which can grow its food with the smallest fraction of its manpower. Only the remaining fraction, the men not needed for growing crops and feeding livestock, can take time off to train for army and navy and air corps, to build bombers and make bullets.

Of all great nations, America grows its groceries with the smallest fraction. Only 100 years ago it took 75 per cent of our people on the farm to grow enough extra to feed (and clothe) themselves and the other 25 per cent. Three could feed four. Now the fractions are reversed. Only 25 per cent of our population is on the farm. It takes only one to feed four. The other three are engaged in creating the comforts and luxuries which we call the American standard of living. If the need comes, at least one of the three can stop fashioning fur coats and finger a trigger.

Why have we been able to whittle down the food-growing fraction to one-fourth?

Not by soil fertility and yield-per-acre, for several of the nations now at each other's throats grow more grain and pasture more beef on an acre. Not by better farm animals, for our best breeds are borrowed from old-world regions whence come such names as Holstein, Guernsey, Angus, Hereford, Leghorn, Merino, Clydesdale.

No, the thing that enables the American farmer to grow such amazing amounts of food is something as distinctly American as baseball—farm machinery. America gave birth to the steel plow, the reaper, the self-binder, the tractor, the combine. No other nation has the skill or the will to use them so well. No other nation puts so much power under the hand of each plowman. None provides so great an investment in machinery for each man.

Because our farm mechanization is so great, our farm fraction so small, we can, if need be, mobilize more of our manpower for a total defense than any other great nation on the globe. Provided, of course, that the other three-fourths of our people can work with a will and an effectiveness anything like that already exercised by the men of agriculture.

The battle of France showed the mastery of machines in offense. The battle of America, if it ever comes, will show the mastery of machines in defense. Foremost among these machines will be those of the farm. And foremost among our preparations to prevent the battle of America must be more, not less, machinery for our farmers.

WALTER B. JONES

Research Is Reflective Thinking

To the Editor:

RESEARCH is largely an orderly thought process. It is not the random course of thinking as a mere chance occurrence. It is the reflective type of thought which involves a sequence of ideas. It is a consecutive ordering of ideas in such a way that each determines the next as its proper outcome, while each outcome, in turn, leans back on or refers to its predecessors. The successive portions of a reflective thought grow out of one another and support one another. They do not come and go in a medley. Each step must be from something to something. These thoughts become a definite chain, all linked together, so that there is a sustained and progressive movement to a definite end. The order may be from known fact to significance, to further significance; or from tentative theory to the conditions under which it would be true, to established fact or to apparent truth which can be checked by experiment.

Thinking is not a case of spontaneous combustion. It does not just happen to occur. The origin of thinking is some perplexity, confusion, or doubt. C. F. Kettering says "Research is not a thing you do in the laboratory. It is a state of mind." It is an active state of mind prodded on and on in reflective thinking by intellectual curiosity and by dissatisfaction with the limitations of existing knowledge and resulting ways of living and working.

Research usually involves seeking the solution for some problem. The first step, therefore, is to note suggestions for a way out—the formation of some tentative plan; the entertaining of some theory or theories that will account for the peculiarities in question; the consideration of some solution for the problem.

The data at hand cannot supply the solution; they can only suggest it. Past experience and a fund of knowledge at one's command are the real sources. If one has had some acquaintance with similar situations, or if he has dealt with material of the same sort before, helpful suggestions will arise, but he must guard against being influenced by preconceived and unproven ideas. Tentative plans or theories must be checked back in reflective thought, through the conditions under which they would be true, to the possibility of such conditions existing, as verified or disproven by known fact or experiment. And the basic data thus determined to bear on the problem and its solution should be checked forward again by reflective thought from proven fact to its primary significance, through any number of successive derived significances, to a resultant significance which may prove, disprove, or improve the tentative solution. Experimenting and testing are not research, but can be valuable aids to this work of checking on the mental processes of research and on the data used.

Agriculture embraces many associated sciences. These sciences are all so interrelated that if they advance, they must all advance together. Like the moving parts of a machine, each science must perform specific functions and must be so coordinated with the others that all move together according to their functional relationships. Each science has in its accumulated knowledge, techniques, and the experience of its personnel, the soundest basis for reflective thinking in its field. With high standards of professional co-operation, the reflective thinking of representatives of all of these sciences can be jointly applied for maximum effectiveness in solving the many agricultural problems which transcend the boundaries of any one science.

EDW. A. SILVER

Chairman
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Equipment for Cultivating Corn

By C. K. Shedd and E. V. Collins

FELLOW A.S.A.E. MEMBER A.S.A.E.

CORN cultivating equipment has been studied in cooperative experiments carried on since 1931 at Ames, Iowa, by the Division of Farm Mechanical Equipment Research of the Bureau of Agricultural Chemistry and Engineering, U. S. Department of Agriculture, and the Agricultural Engineering Section of the Iowa Agricultural Experiment Station. The purpose of this paper is to discuss some of the results obtained in these investigations. This discussion will cover only equipment for cultivating surface-planted corn.

Seedbed Preparation and Planting. The success of any cultivating procedure depends to some extent upon previous treatment of the soil and method of planting the crop. The principal purpose of cultivating corn is to kill weeds. It is advantageous to germinate and destroy as many weed seedlings as possible in the process of preparing the seedbed, but this does not necessarily call for any excessive amount of work on the seedbed. It was observed at Ames that weed growth did not usually appear in plowed soil until about May 1. For planting from May 10 to 15, one thorough tillage with tandem disk harrow and spiketooth harrow just before planting was sufficient to destroy weed growth. Additional tillage operations prior to that time did not produce any benefits as to weed control nor as to germination and growth of the corn.

One of the requirements of a good seedbed is that the soil surface be planed or leveled so that the planter will deposit the seed at uniform depth in moist soil. This insures prompt germination of all the seed, with the result that the corn plants will all be about the same size at the time of first cultivation.

Presented before the Power and Machinery Division at the Fall Meeting of the American Society of Agricultural Engineers at Chicago, Ill., December 4, 1940. Journal Paper No. J-811 of the Iowa Agricultural Experiment Station, Project 396. Authors, respectively, agricultural engineer, Bureau of Agricultural Chemistry and Engineering, U. S. Department of Agriculture, and research professor of agricultural engineering, Iowa Agricultural Experiment Station.

Methods of Destroying Weeds. Cultivating equipment makes possible three methods of weed destruction, namely, (1) uprooting the weed, that is, separating the roots from their emplacement in the soil and exposing them to drying conditions, (2) smothering the aerial parts of the weed by covering with soil, and (3) deep-rooted weeds may be destroyed or controlled by severing the aerial parts from the root system.

In the space between corn rows all of these methods may be applied vigorously at each cultivation, and hence there is little difficulty in destroying weeds in this space. The place where it is difficult to control weeds is in the corn row. Weeds in the corn row may be uprooted at the seedling stage of growth by use of a harrow, a weeder, or a rotary hoe which scratches or digs the soil surface enough to uproot weed seedlings, but not enough to injure the corn plants seriously. Success depends upon relative resistance of weeds and corn plants; that is, the corn plants must be well established while the weeds are at a tender stage of growth. These machines are most effective when the soil surface has been lightly incrusted by moderate rainfall. They are of little use if the soil is heavily incrusted by intense rainfall or if the soil surface is loose and dry due to lack of rain.

In later cultivations covering is depended on entirely to kill weeds in the corn row.

Early Cultivation. Machines for early cultivation were compared in an experiment carried on from 1934 to 1939 with yield results as recorded in Table 1. After the cultiva-

TABLE 1. EFFECT ON YIELDS SHOWN BY EARLY CULTIVATION OF CORN WITH VARIOUS MACHINES

Plot No.	Machine used	Average yields, bu. per acre 1934	1935	1936	1937	1938	1939
a	Spring-tooth weeder once						67.3
b	Spring-tooth weeder twice	21.0	42.1	32.6	70.6	68.1	65.7
c	Rotary hoe twice	21.7	38.4	33.0	70.2	67.8	
d	Spike-tooth harrow twice	22.5	37.8	33.3	67.0	67.2	
e	Sweep cultivator once	21.2	46.2	32.9	70.0	69.3	70.8
f	No early cultivation	23.7	34.7	32.8	68.7	68.2	71.3

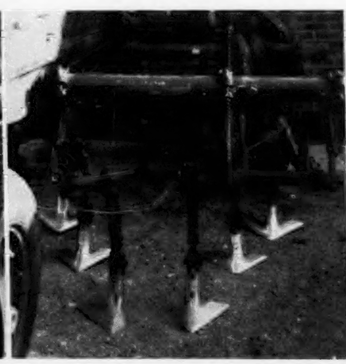
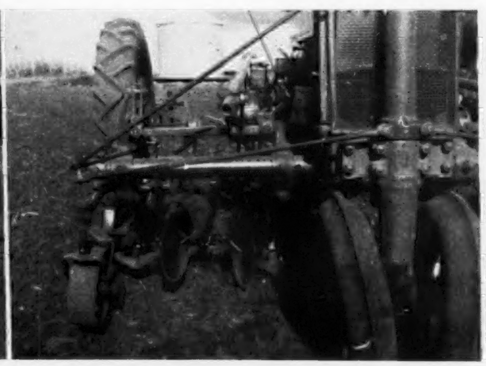




Fig. 1 (Left) Six full sweeps per row and rotary hoe shields were the best equipment tried for first cultivation when corn plants were small. Fig. 2 (Center) When first cultivation could be delayed until corn plants stood about 6 in high, it was found better to leave off the shields and use half-sweeps next to the corn row. Fig. 3 (Right) For second cultivation the front sweeps were replaced with disk hillers modified by the addition of scrapers to prevent covering of corn plants


Fig. 4 (Left) For weedy conditions, especially morning-glory vines, two pairs of disk hillers and one pair of sweeps per row were highly effective equipment. Fig. 5 (Right) An experimental weeder-tooth rear attachment for a tractor cultivator completed the kill of weeds, filled tractor wheel tracks, and left the space between rows nearly level

tions listed in the table all plots were treated alike, that is, given two cultivations. The experiment was of replicated plot design. Statistical analysis of yields showed that the differences in yield obtained by use of the different machines for early cultivation were highly significant in 1935 and 1939, significant in 1937, and not significant in any of the other years. In 1935 there was excessive rainfall in June. Second cultivation (first cultivation of "f" plots) was delayed to July 8. In 1939 there was no effective rainfall after planting until after the period of early cultivation. The use of the weeder proved to be harmful under 1939 conditions. Weed control was not measured numerically. Observation of weeds present at time of harvest showed good control of weeds each year and no observable difference between plots, except in 1935, when the "e" plots were cleaner and the "f" plots weedier than the others.

Cultivator Equipment. Sweeps and disk hillers were found preferable to pointed shovels for use on tractor cultivators. Sweep tracks overlap so that all weeds in the space between the rows are sheared off without deep cultivation. Sweeps give less trouble than pointed shovels by clogging with cornstalks or other trash embedded in the soil. Sweeps throw less soil than do pointed shovels, but they can be adjusted to move enough soil into the corn row to cover ordinary weed growth at the first cultivation.

For first cultivation, if performed when the corn plants were small (less than six leaves), the most effective equipment was six full sweeps per row and rotary hoe shields as shown in Fig. 1. The rotary hoe shields regulated more uniformly the amount of fine soil thrown into the corn row and gave less clogging trouble than did the commonly used sheet-steel shields.

It was found best, when conditions permitted, to delay first cultivation until the corn plants stood about 6 in high. Then half-sweeps without any shields were used next to the corn row as shown in Fig. 2.

For second cultivation, it was usually found advantageous to replace the front pair of sweeps with disk hillers. Disk hillers as purchased from manufacturers were modified experimentally by the addition of scrapers (Fig. 3) which were adjustable as to distance above the ground surface. Without scrapers the disks tend to throw soil high enough to cover corn plants. Scrapers turn the soil into the corn row and prevent it from being lifted higher than the position of the scraper. Disk hillers with scrapers were used in some cases when corn plants stood only about 6 in high. They move a more uniform amount of soil into the corn row than any type of shovel and are free from difficulty of clogging with either trash or vine weeds.

For the last cultivation the equipment generally found most effective was one pair of disk hillers and two pairs of sweeps per row, the same as described above for second cultivation, except that scrapers were not used on the disks.

For killing morning-glory vines, two pairs of disk hillers and one pair of sweeps per row, as shown in Fig. 4, were the most effective equipment. The front pair of disks throw soil away from the corn row; the second pair throw soil back into the corn row; and the sweeps cut the remaining space between rows.

The best rear attachment for a tractor cultivator was an experimental spring-tooth weeder, shown in Fig. 5. This attachment consists of weeder teeth set in lines at about a 45-deg angle with the corn row. The teeth in this position move loose soil away from the corn row, fill tractor wheel tracks, and leave the space between rows nearly level. They do not disturb the soil in the corn row, which has been put there to cover weeds. The weeder teeth complete the kill of weeds by raking them to the surface. By changing the spacing of the teeth for various conditions, excessive accumulation of weeds or trash on the teeth can be prevented.

This weeder-tooth rear attachment is advantageous for cultivation of drill-planted corn as it reduces the amount of ridging of rows and eliminates any furrow between rows which might interfere with guiding the tractor at the next cultivation or at harvest. For checkrowed corn the reduced ridging makes the tractor and cultivator ride smoother and do better work in crossing ridges.

With the cultivator equipment described above it was found possible, under ordinary soil and weather conditions, to accomplish almost complete destruction of weed growth at each cultivation. The use of this equipment resulted in better control of weeds than is accomplished under ordinary good farming practices and in some cases this was done with two cultivations instead of the customary three cultivations.

An important feature of the results obtained by use of this equipment was that, over a five-year period, weeds were controlled practically as well in drill-planted as in checkrowed corn. Under extreme weather conditions, causing long delay in cultivation, more complete destruction of weeds can be accomplished in checkrowed than in drill-planted corn, but the results of this study show that improved cultivator equipment makes drill planting a safe practice in central Iowa.

Maintenance of Open Drainage Ditches

By E. A. Krekow
MEMBER A.S.A.E.

ANY WORK done on a constructed drainage improvement is generally considered maintenance. This broad interpretation is used in discussing maintenance of open ditches.

The type of open ditch discussed in this paper is the one constructed primarily for an outlet to tile drains and for auxiliary surface drainage. These ditches drain land within the boundaries of incorporated drainage districts in north central Iowa, which lies in the Wisconsin drift area. Similar drainage ditch construction is found in north central Illinois and parts of Ohio and Indiana. Studies of the drainage problem discussed in this paper were made primarily in Kossuth and adjoining counties in Iowa.

Soils of this area are dark colored and were developed from glacial drift under the influence of grass vegetation. The principal upland soils are in the Clarion, Webster, and Dickson series. These soils, when drained, are well adapted to clean-tilled crops, grain, and hay. About 91 per cent of all land in Kossuth County, where adequate drainage is provided, is class I land.

In topography, this area is generally flat to undulating, marked here and there with a low hill or ridge. The surface is marked by numerous flats, depressions and potholes, and scattered nobby hills rising from 15 to 20 ft above the general level. Natural drainage of the area is rather incomplete and normally inadequate. Flood planes of the streams are not wide. In a few places they are as wide as ¼ mi, and in places along the east fork of the Des Moines River they reach a width of ½ mi. In general, these flood planes are still in bluegrass pastures.

Studies and observations on drainage have been carried on since June 1935 at the CCC drainage camp at Bancroft, Iowa. This camp was set up by the U. S. Bureau of Agricultural Engineering as the first drainage camp in the nation. It was transferred to the Soil Conservation Service in July 1939. The camp has reconstructed 117.75 mi of open drain, excavating 1,658,700 cu yd of dirt, leveling 155.07 mi of spoil bank, and moving 1,850,622 cu yd of dirt. Approximately 22 mi of tile relay and reconditioning work has been completed. All work is in cooperation with public drainage enterprises.

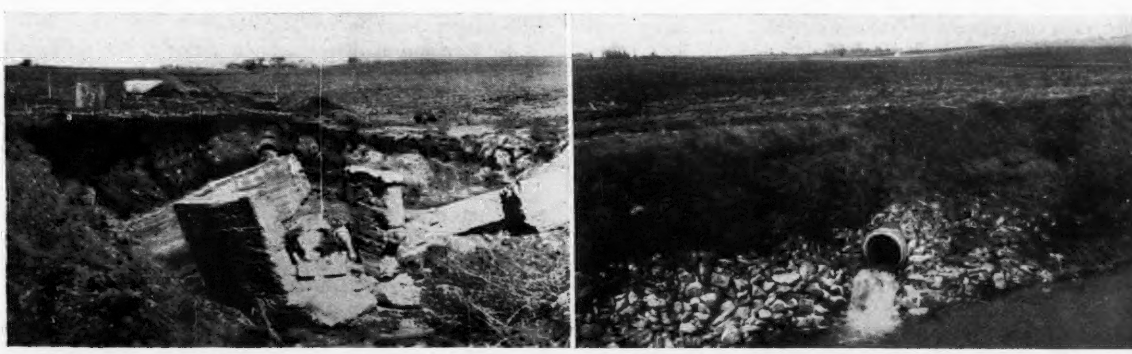
Most of the present public ditch systems were originally constructed with floating dredges, which were the most suitable equipment available for such work on wet swampy land. Although the ditch system designed generally called for a side slope of 1-to-1, it was impossible for this machine to dig the bottom narrow enough and still permit passage of the machine for further digging. The final section had the shape of the letter "U".

Two types of soils which gave the contractors much trouble were sandy loam and claypan. The sandy loam had a tendency of sloughing in soon after the dragline passed. No effort was made to remove this fill after grade check had supposedly been made, or after the contractor had worked a few thousand feet beyond. When claypan was encountered and the dipper could not remove it with normal operation, the contractor would slide over it. Ditches have been reconstructed to original grade where they had 2 or 3 ft of claypan that should have been removed in the original construction. The sloughing of sandy loam soils was increased by spuds which were required to carry the machine on the ditch berm, and by high water at the time of construction. This sloughing usually took place immediately following passage of the machine, or during the following spring after frost action had completed breaking the cleavage of the soil. The original design of several ditches made too frequent breaks in the bottom gradient, apparently in order to reduce yardage and decrease the cost. Construction of ditches on these grades had a tendency to cause silting and to reduce the carrying capacity.

Another factor which caused the ditches to deteriorate was the failure to level spoil banks. The common practice at the time was to leave openings in the spoil bank line, or at coaling stations for surface runoff. The overfall of surface water at these openings resulted in erosion and subsequent silting in the ditches. In addition, erosion occurred on both the berm and the spoil bank from water that fell on the inside slope of the spoil bank.

Structures that were placed along the ditch to serve as tile outlets or surface water inlets were constructed of bulky concrete material. Concrete headwalls were generally constructed with their bases well above the grade line of the

Presented before the Soil and Water Conservation Division at the fall meeting of the American Society of Agricultural Engineers at Chicago, Ill., December 6, 1940. Author: Superintendent, CCC drainage camp (Bancroft, Iowa), Soil Conservation Service, U. S. Department of Agriculture.



(Left) A washed-out tile outlet and headwall in a drainage ditch in Iowa. (Right) Replaced outlet for the same tile line, located 100 ft down the ditch from the old outlet and protected from undercutting

open ditch. The foundations did not have sufficient bearing or depth to maintain the structures in place. They settled, causing breaks in the flow line of the tile just back of the structures, which resulted in complete failure.

The above factors were among the chief causes of silting in ditches before reconstruction. They were responsible for silt covering tile line outlets to depths of 2 to 5 ft, sloughing of original berms, erosion of spoil banks, erosion of ditch banks at the outlets of surface drains, tile blowouts, and failure of concrete structures. Bridge piling and cross fences placed on the ditch base, catching trash deposits, also helped decrease the carrying capacity of the ditches. The unleveled spoil was an ideal seedbed for cottonwood trees which flourished along the ditches. The trees must be removed before dragline cleanout can take place.

In reconstructing open ditches, one of the most difficult tasks is clearing and grubbing the many cottonwood trees ranging in diameter from 8 to 42 in. These trees are cut down by hand labor, and the stumps removed by dynamite. In order to reduce the cost of grubbing, only sufficient dynamite is used to blow the stump loose.

An uneven spoil bank with large tap roots, fragments of stumps, and large boulders slows up the operation of a small dragline in building a track or roadway preliminary to ditch excavation. In the Bancroft camp area, a large tractor equipped with an angledozer was used to complete the grubbing operation, to remove the roots, and to make a track for the dragline. Our cost data indicate that, in some cases, at least, there has been a saving in cost because the tractors can move from 150 to 200 yd per hr. A $\frac{1}{2}$-yd dragline under the above conditions can move only about 40 yd per hr.

DRAGLINE CLEANOUT

Bulldozing operations leave an ideal roadway approximately 24 ft wide (varying with size of bank) at a height ranging from 2 to 4 ft above the natural surface. The bulk of the new spoil is thrown over the edge of this roadway by the dragline. The new spoil is again leveled in the same manner as the old bank. This roadway gives the engineer a much better opportunity to set slope stakes so that they can be readily followed by the dragline operator. The cross sections tend to become more uniform. Leveling of the new spoil leaves the roadway for all maintenance operations and permits travel on the district's own right-of-way.

Since 1937, ditches have been cleaned out with two draglines operating simultaneous on each side of the ditch. Results from this method have been excellent. With a dragline on each side of the open ditch there is no undercutting of the opposite bank. Tracks are built ahead of the dragline so that the operators are able to follow the slope stakes to such a degree that no loose material whatsoever is left on the side slopes of the open ditch. This slope is generally cut between $1\frac{1}{2}$ to 1 and 2 to 1. The steeper side slopes have proved satisfactory for heavier soils where greater capacity is needed. Simultaneous cleanout by two draglines is especially well adapted for the two soil extremes; claypan, which lends itself well to this crisscrossing digging operation; and waterbearing sand, which requires the draglines to dig in carefully so that no puddling takes place. Care must be taken so that this section is not dug below grade, as it has a tendency to increase sloughing from the sides. Draglines are operated in two 8-hr shifts. We do not recommend any bottom width less than 6 ft.

Cross fences and water gates are now also receiving considerable attention. The ideal water gate would probably consist of electric fence mounted on floats, but icy conditions in winter make this type impractical for this area. We have been experimenting with a simple vertical gate hung either from a bridge or from a $\frac{3}{4}$-in reinforcing rod thoroughly anchored in the side slopes of the ditch above the high-water line. In addition to taking care of the entire cross section, the districts are urged to extend the district fence to a point 20 ft beyond the crest of the cross section so that a gate could be put in this section of the fence to permit travel by car for inspection and maintenance.

Tile and surface outlets are repaired so that the last 16 ft of tile lines 12 in and under in diameter, and the last 22 ft of tile lines over 12 in, outlet through either a corrugated pipe or a lock-joint concrete pipe. Where the tile joins the pipe, a heavy concrete collar is placed at the junction of the tile and pipe to serve as an anchor and to prevent seepage. At the outlet end a concrete flume is placed along the slope to conduct the water down to the bottom of the ditch. Care is taken in placing the pipe so that the outlet end of the pipe intersects the slope of the ditch bank. The reason for this is that, where the pipe protrudes beyond the point of intersection, snow and ice action tend to tear the pipe apart. What generally happens is that the rivet holes shear out near the point of intersection. It has been possible to shorten the length of surface pipe a great deal by recessing into the spoil bank, digging out a trapezoidal section of the spoil and using only a 22-ft length of surface pipe. All pipes less than 20 in in diameter are placed at right angles to the ditch. They have a slope of 1 ft per 22 ft, outletting into the concrete flume. A collar, similar to the collar on the tile outlet, is placed at the end of this pipe to protect it.

SEEDING OF DITCH BANKS

Immediately following dragline cleanout, the side slopes of the open ditch are seeded with sweet clover and bromegrass, and because a good stand is required as soon as possible, this grass mixture is seeded at the rate of 15 lb per acre. In addition, farmers and landowners are cooperating by seeding from the crest of the cross section to a point 100 ft beyond and parallel to the ditch.

Alfalfa or a mixture of sweet clover, bluegrass, and bromegrass is sown to give a sod cover to prevent erosion. The sweet clover along these slopes makes fine cover for pheasants. In addition to this, special vines and low-growing bushes are planted at points where they do not interfere with farming operations or ditch maintenance.

Permanent maintenance has been introduced to some degree in this area. Ditches are patrolled every September or in the fall, and all the young trees are cut. Because of thorough grubbing and cleaning, few trees grow. Two men can cover both sides of 5 mi of open ditch in one day. Broken tile lines are repaired.

SUMMARY

A few of the things needed to encourage a better maintenance program are as follows:

1 Revision of drainage laws. Some of the points that should be included in this revision would be a consolidation of districts or a larger taxing base, with perhaps even the entire county as a unit.

2 Small annual levy in lieu of the special assessments as now spread.

3 Interchange of equipment between drainage districts and county road maintenance departments on a rental basis.

4 Permanently appointed drainage maintenance engineer whose duties would be similar to the present county engineer with relation to roads.

5 Good land use practices. This could best be accomplished by cooperation between the drainage engineer and the county agent, as well as cooperation with state and federal agencies.

The Installation and Operation of Jet Pumps

By F. R. Elliott and W. J. Conery
MEMBER A.S.A.E.

THE jet or ejector pump is a combination of two old and well-known principles, the centrifugal pump and the ejector. These two principles operating in series in a single unit comprise the present-day jet pump, which lifts water from wells of moderate depths with reasonably satisfactory efficiency.

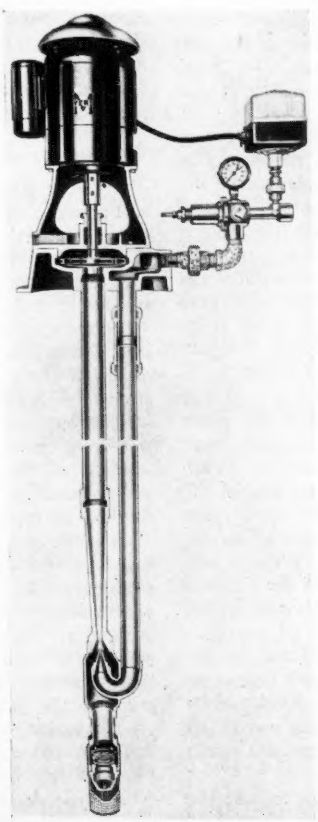
About thirteen years ago, on the Pacific Coast, the first attempt was made in this country to use such pumps for domestic service. The first units were made up with horizontal centrifugal pumps, and were not readily accepted because they were rather crude and inefficient. A few years later the vertical type was developed, using capacitor type motors, and several small manufacturers began building such pumps on the Pacific Coast. The industry was largely confined to California in its early years, and got its start there because well conditions were ideal for the use of the jet type pump.

As the interest in this type of pump increased, several of the larger manufacturers with national distribution entered the field and various improvements and refinements were made. Improved design and efficiency in the pump and in capacitor type motors have been responsible for rapid expansion of the industry. Operation at 3600 rpm is necessary to secure greatest simplicity and efficiency. At this speed repulsion-induction, single-phase motors were not satisfactory because of brush and commutator trouble. The power curve of the repulsion-induction motor also does not parallel the curve of the pump load. Improvement in the design and performance of the capacitor motor of 3600 rpm provided a quiet, reliable, trouble-free motor perfectly suited to the job.

Construction of the jet pump is simple and compact and appeals to the average buyer. The unit above ground is usually a vertical single-stage centrifugal pump with cast-iron volute case, bronze impeller, and stainless steel shaft. The shaft and impeller are the only moving parts. The shaft is usually coupled directly to the motor shaft. In some designs an extended motor shaft is used, with the impeller mounted directly on the motor shaft and with a renewable sleeve on the shaft where it passes through the stuffing box. Usually metallic packing is used in the stuffing box, making a good water seal and acting as a steadying bearing for the shaft. The stuffing box should always be located on the pressure side of the pump to prevent air leaks through the packing. Since there are no bearings in the pump itself, no lubrication of the pump is necessary. The motor is of the ball bearing type and requires lubrication at only infrequent intervals.

In most designs the ejector or jet assembly to go down in the well is made of bronze. This assembly includes three principal parts—the ejector body, the nozzle, and the venturi or discharge tube. The design, shape, and accuracy of finish of these parts materially affects the performance and efficiency. Lead, rubber, glass, and porcelain have been used for lining the venturi tube, but bronze can be machined accurately and smoothly for best performance, whereas other materials may be wavy or be difficult to hold to smooth, accurate shapes and tolerances necessary for maximum efficiency.

Most ejector pumps use two pipes in the well. One pipe, usually the smaller of the two, is used to convey the pressure feed water to the ejector nozzle, where it is delivered at high velocity into the throat of the venturi, thereby creating a vacuum. The vacuum draws water in from the well through a foot valve at the bottom of the ejector body. This water from the well is mixed with the feed water in the venturi tube. Here the high velocity of the stream is converted into useful pressure by a gradual reduction in velocity, accomplished by the conical shape of the venturi tube. The high velocity of the water through the ejector nozzle not only serves to draw water in from the well through the foot valve, but also raises the water toward the surface to within the suction lift limit of the centrifugal pump through the delivery or suction pipe.



A view of a motor-driven jet or ejector pump

Other designs of ejector assemblies are made for use in small diameter wells. The most common of these are made with a rubber seal or packer and are placed directly into the well, using the well casing for the pressure pipe. With this type the pressure water is forced down in the annular space between the well casing and the delivery pipe. The return water then comes up in the center or delivery pipe. This type has the advantage of obtaining higher capacities from small diameter wells. The rubber seal is expanded in the well by turning the delivery pipe after the pipe and ejector are set at the proper level. The well is sealed at the surface with some suitable coupling.

For the ejector pump to be properly sold and installed it is very important to understand the operating characteristics and limitations of this type of pump. When properly installed for the conditions for which it is intended, good results will be obtained, but if improperly installed, it may prove disappointing. It must be understood that the characteristics of the combined centrifugal pump and ejector are very similar to the characteristics of a centrifugal pump, that is, at low pressure the capacity is high, and as the pressure is increased the capacity falls off. The power curve for the ejector or jet pump is usual-

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ly the rising type, that is, the power is highest when the pressure is lowest. This varies, however, depending on whether the ejector is for high head or low head. The low head ejector has a rising power curve; and the high head ejector has practically a constant or horizontal power curve.

These characteristics of the ejector pump are desirable from a safety standpoint, for there is no danger of excessive pressure or excessive load on the motor as is possible with the reciprocating type of pump. The ejector pump also supplies a steady flow of water.

A pump for pressure system operation must be capable of producing the required pressure for satisfactory automatic operation. In small domestic type units this is usually 20 lb starting pressure and 40 lb cutout pressure. This means that a pump of the centrifugal type, to deliver any quantity of water at 40 lb pressure must have a shutoff pressure somewhat higher than 40 lb. With small single-stage centrifugal pumps, high pressure is not easily obtained with good efficiency, but by using the ejector with the centrifugal it is possible to obtain a pressure much higher than the centrifugal pump is capable of producing. Using the ejector with the centrifugal pump does three things. It makes possible pumping from deep wells with no moving parts in the well. It makes possible the use of a centrifugal pump of fairly high capacity but relatively low pressure, giving high efficiency. It makes possible satisfactory operation at higher pressures than with the centrifugal pump.

OPERATING CYCLE AND CHARACTERISTICS

The cycle of operation of the jet pump is as follows: After the pump is primed, this being done by filling feed and delivery pipes with water until all air is expelled, the motor is started with the regulating valve closed, and immediately a vacuum is produced on the suction side of the centrifugal pump and a pressure on the discharge side. Some form of regulating valve must be used on the discharge side of the pump as it is necessary to build up a certain back pressure to make the ejector operate. As the control or regulating valve is opened, the pressure on the discharge side of the pump drops, this also drops the pressure in the feed line to the ejector assembly. This pressure is reduced to a point where it will become unstable, then the valve is set so that the pressure is 2 to 5 lb higher for permanent operation. When the pressure is reduced to this minimum point, the centrifugal pump is operating at its maximum suction lift and the ejector pump unit is operating at its minimum discharge head, so at this point the highest capacity is obtained. It is apparent that if the centrifugal pump is operating under a vacuum, no pressure is being delivered to the centrifugal pump from the ejector; so at this point the total discharge head obtained is coming entirely from the centrifugal pump. As the discharge pressure builds up, it is necessary to obtain pressure on the suction side of the pump from the ejector. As the pressure builds up, a point will be reached where there is zero pressure at the suction of the centrifugal. At this point the discharge pressure will still be that of the centrifugal pump. Now as the pressure goes higher, there will actually be a positive pressure on the suction of the pump from the ejector which of course is added to the discharge pressure already developed by the centrifugal pump. From this then it is apparent that at all points of operation the pressure and capacity developed by the centrifugal is practically constant. In other words, all changes in pressure are obtained from the ejector unit rather than from the centrifugal.

From this it can be seen that it is important to have the ejector nozzle and venturi designed so that the centrifugal pump will operate at a capacity and pressure near its peak performance. The individual manufacturers design the centrifugal pump and the ejector to work together for the best efficiency obtainable and the complete job should be purchased as a unit for best performance.

Why does the ejector pump drop off in capacity as the well lift and pressure increase? As pointed out before, the combined characteristics of the ejector and centrifugal pump are similar to those of a centrifugal pump. Therefore, the jet pump has a fixed head capacity or a maximum total head that it can develop. The total head developed by the jet pump is the sum of the lift from the well and the discharge head above ground. Therefore, the greater the lift, the less pressure or head will be available above ground, and consequently the less capacity. This means that the ejector is definitely limited as to lift and pressure for a given size pump. There is still another factor that tends to limit the capacity and efficiency of the ejector for deep lifts. The head and capacity a given ejector will produce depends on the ratio of the area of the nozzle to the area of the throat of the venturi tube and to the pressure applied to the ejector nozzle. A low-lift ejector has a high ratio of nozzle area to venturi area, and a high-lift ejector has a low ratio. As the capacity and pressure of the centrifugal pump remains practically constant when operating with the ejector, the amount of feed water plus the amount of water delivered for use must equal the capacity of the centrifugal pump. From this it can be seen that the less water circulated for feed supply, the more will be available for use. A low-head ejector or one that is designed for low-lift requires less feed water for the amount delivered than an ejector designed for high lift. This means that the low-head ejector is the most efficient from the standpoint of circulation to delivery, and also, due to less shock, is more efficient hydraulicly than the high-head ejector. For these two reasons, it is apparent that the ejector pump is intended for low lift for best performance. Because of these various factors, accuracy in design and finish are of great importance.

SUITABILITY IN RELATION TO OPERATING REQUIREMENTS

The jet pump should be used only within its well lift and pressure range and only for service that does not require constant operation at high pressure. It is ideally suited for the domestic water system that uses a 20 to 40-lb pressure range, and where a large quantity of water at low pressure is usually desirable.

The fact that the jet pump does not have to set directly over the well to operate is a desirable feature. It is possible to install the pump at any convenient location away from the well if the distance is not too great. That it requires no lubrication, is quiet, has no moving parts in the well, and is easy to install, are all points in favor of its use.

One of the most important things in the satisfactory performance of a residence water system is a dependable method of providing an air cushion in the pressure tank. Various devices have been used and some jet systems have had no provision at all for supplying air to the tank. The problem of the air supply is not a simple one with the jet system because the centrifugal pump will not handle air satisfactorily. The manufacturer who develops a more practical and effective method of supplying air to the pressure tank, than anything that is now in use, will have contributed much to the development of the jet type water system.

In conclusion, it may be said that the jet or ejector pump definitely has a place in the domestic water system field, provided it is operated within its limitations. The reciprocating type deep-well pump will always be in demand and will be used where well lifts and pressures are beyond the range of reasonably efficient performance for the jet pump.

New Developments in Forage Harvesting Machines

By F. W. Duffee
FELLOW A.S.A.E.

I BELIEVE the development of machinery for producing the hay crop has been neglected, probably because the crop is fed on the farm where produced to a large extent, whereas the other major crops are largely cash crops, and for that reason we have not appreciated the value and importance of the hay crop. Table 1 shows that it is one of the four major crops in the United States. These four crops comprised 88 per cent of all the crop acreage harvested in 1939, and the great "triumvirate"—hay, grain, and corn—in which we in this region are interested, accounted for 80 per cent of the 1939 crop acreage.

To show how far these four surpass any other crop in acreage, I point out that grain sorghum is next, but it uses about one-seventh the acreage of hay.

TABLE 1. ACREAGES OF MAJOR CROPS

Crop	1928-37 average (1000 acres)	1939 (1000 acres)	1940 (1000 acres)	Per cent increase (+) or decrease (—), 1940 over 1928-37 average
Wheat	55,804	53,696	52,680	
Oats	37,452	33,070	34,585	
Barley	11,017	12,600	13,290	
Rye	3,179	3,811	3,086	
All small grains	107,452	103,177	103,641	— 3.5
All corn	99,798	88,803	86,306	—13.5
All hay	67,671	69,245	71,551	+ 5.7
Cotton	34,984	23,928	24,406	—30.0
Grain sorghums	7,293	8,055	9,523	+30.5

(From Crops and Markets, vol. 16, no. 12, p. 264, for all data except 1940)

Hay is grown in every state, varying from 6 per cent of the harvested crop land in Texas and Florida to 92 per cent in New Hampshire. The importance in the Middle West is shown in Table 3.

As I pointed out in December, 1938, there had been at that time practically no development of new methods in making or handling the hay crop for the last 60 years, whereas during this same period of time, wheat and corn have been completely mechanized and the mechanization rather widely adopted.

An analysis was made then of the comparative labor requirements of the field baler and the large field chopper, showing an advantage in favor of the field chopping method of 13 to 1, in so far as the work involved in getting the hay onto the wagon was concerned. The prices of these units would be about the same.

Also, the field baler will merely bale hay and straw and drop the bales on the ground, and we still have all the problems attendant on curing hay; in fact, they are probably magnified. Such meager data as we have found indicates that the hay must be dryer for baling than for storing loose. Alfalfa hay chopped with an ensilage cutter set for 1¾ to 2-in cut can be stored in ventilated bents 6 to 8 ft wide with a moisture content of 25 per cent.

On the other hand, the forage harvester will pick up, chop, *and load* hay and straw, harvest grass silage, and serve as a stationary ensilage cutter for corn, if not a field ensilage corn harvester, and one of the greatest advantages from the farmer's point of view is that it is relatively low in cost and will replace more of the machines he now has than will the baler. From the implement manufacturer's point of view, I would say that the opportunities for volume sales with the forage harvester appear to me to be much greater than for the field baler.

I believe the forage harvester is of profound significance, as it represents the last link in the development of mechanized agriculture, in so far as the three major crops outside the cotton belt are concerned. I repeat that we have mechanized grain and corn, but not hay; when hay-making is fully mechanized, we will then for the *first time* have fully mechanized agriculture in so far as the field work is concerned on millions of American farms.

During the last seven or eight years, grass silage has come into prominence, but present methods of handling this crop, that is, with the hay loader and ensilage cutter, are far from satisfactory. In a Wisconsin survey, twenty-seven out of eighty-three farmers expressed dissatisfaction with present machinery, thirty-two expressed neither advantage nor disadvantage. Several farmers with whom I have discussed this matter, have discontinued the practice because of the extremely hard work and the large amount of labor involved. They say they will again put up grass silage when suitable machinery is available.

PRESENT STATUS OF FORAGE CROP HARVESTING MACHINERY

The term "forage crop harvesting" is intended to include grass silage, dry hay, straw behind the combine, and it is to be hoped that the field harvesting of corn for ensilage may also be included.

The Fox River Tractor Co. has completed the fifth year of commercial production of their large machine, and during the past season the following companies had experimental machines in the field: Allis-Chalmers Mfg. Co., Eagle Mfg. Co., Gehl Bros. Mfg. Co., John Deere Plow Co., International Harvester Co., and Massey-Harris Co. There may have been others which have not come to our attention. Interest in this method of harvesting grass silage and hay is evidenced by the fact that there have been several

TABLE 2. FARM VALUE OF THE MAJOR CROPS, 1939

Crop	Total production (thousands)	Average farm price	Total farm value (millions of dollars)
Wheat	754,971 bu	73.1 cents	550
Oats	937,215 bu	32.1 cents	300
Barley	276,298 bu	42.2 cents	116
Rye	39,249 bu	44.6 cents	17.5
All small grain			983.5
All corn	2,619,137 bu	46.8 cents	1,230.0
All hay	84,526 tons	\$ 7.51	635.0
Cotton lint*	11,792 bales	\$44.00	519.0
Cotton seed	5,239 tons	\$23.75	124.0
All cotton			643.0

*Cotton lint 8.8 cts. per pound — 500 lbs. per bale.

SUMMARY OF THE FOREGOING

Crop	Total farm value (millions of dollars)
Corn	\$1,230.0
All small grain	985.5
All cotton	643.0
All hay	635.0

A paper presented at a joint session of the Power and Machinery and Farm Structures Divisions at the fall meeting of the American Society of Agricultural Engineers at Chicago, December 4, 1940. Author: Chairman, agricultural engineering department, University of Wisconsin.

homemade machines built during the last two or three years; it is reported that one mechanically minded farmer in Iowa built and sold some five machines in the early part of 1940.

Forage harvesting equipment was demonstrated at the annual field day of the Wisconsin agricultural experiment station last July, and the attendance broke all previous records by a very wide margin, due to this particular event.

Performance. It was not possible for us to obtain extensive data on the performance of the experimental machines due partly to lack of personnel and partly to the fact that a great deal of experimenting was done with the machines under observation. However, some data was secured from nine different farms, covering performance on three of the small experimental models having widths of cut ranging from 36 to 48 in, and one Fox machine.

To me the real significance of this data is to show us just how far we have travelled along the road to what might be called a satisfactory machine. Two of the machines having widths of 36 in and 40 in, respectively, performed rather consistently at an average rate of 6 tons per hour for one-half day runs. Occasional runs of 2 to 3 hr showed rates up to about 9 tons per hour. The power used in these cases varied from about 25 to 28 hp. Operation of the harvester was by power take-off, and in some cases the wagon was pulled behind the harvester. In one case about 600 tons of a mammoth growth of sudan grass and soybeans were put up. On one day approximately 100 tons were cut with two machines in about 7½ hr.

COMPARISON OF NEW AND OLD EQUIPMENT

One farmer reports as follows: "Four men did approximately 1½ times as much work putting up grass silage in a day as 8 men did last year with the mower, hay loader, ensilage cutter method." This is a ratio of 3 : 1 in man-hours per ton. Another farmer "estimates it would take 6 men about 4 days to fill a particular silo by the old method, and 4 men could fill the same silo in 2 or 3 days with the new method, and with much less hard work. There would be one additional man in the silo in each case." A ratio of about 2½ to 1 man-hours per ton. A report from another of the experimental machines with a 48-in width showed a rate of 15 tons per hour in soybeans. A tractor of slightly less than 25 hp was used, but the wagon was pulled by other power. This performance more nearly represents what we would expect such a machine to do.

The best record we have heard of so far was reported by a custom operator who says he filled a 16x60-ft silo (about 325 tons) in 15 hr of operating time, using a Fox machine equipped with a power plant. Side delivery was used, and two dump trucks used for hauling to the blower. The alfalfa was cut by two 5-ft mowers and raked with a side rake ahead of the harvester. This represents a rate of about 22 tons per hour.

We have no data on the performance of the small experimental machines on dry hay although they were used rather extensively for this purpose.

A farmer in Iowa reports on chopping straw as follows: Two 5-ft swaths as left by the combine were raked together; the straw was heavy and somewhat weedy. The tractor was operated at 4.75 mph, and a large box rack 7x14x6½ ft could be filled in 20 minutes.

Recent Development. I believe that more real progress has been made on these experimental machines since September 15 than in the two years prior to that time. At about that date three of the larger companies got together and

TABLE 3. NUMBER OF SILOS AND PER CENT OF CROP LAND IN HAY

State	Number of silos*	Per cent of crop land in hay, 1939
Wisconsin	107,200	41
Minnesota	48,506	23
New York	47,813	60
Pennsylvania	31,200	38
Iowa	27,160	17
Michigan	23,560	35
Illinois	17,026	15
Indiana	12,480	20
Nebraska	11,853	17
Ohio	11,813	27
Kansas	11,773	7
United States		21.2

*Information available in a few cases indicates that the number of silos as shown by the 1940 census will probably be larger than shown here.

exchanged ideas freely. This pooling of information led to extensive improvements by all three.

I believe I express the appreciation of farmers generally and of this organization when I commend this forward step of these men of the agricultural equipment industry, a practice which has been followed for many years with great success by the automobile industry. I sincerely hope that this collaboration comes to the attention of the heads of these and other organizations and that this becomes a general practice in the industry. Too often we hear farmers complaining that machines are weak or inefficient at certain points, and that if they could get all the good points of all machines into one machine, they would have an excellent machine.

Anticipated Performance. I do not wish to pose as a prophet; however, on the basis of most recent developments, I fully expect to see these small machines handle up to an average of 10 or 12 tons of grass silage an hour when pulled by a 25 to 30 hp tractor, and probably 6 to 8 tons per hour when pulled by a one-plow tractor. The crew would consist of four men as at present (outside the silo): one driving the tractor on the harvester; one loading if the wagon is hitched behind the harvester, or driving if the wagon or truck is pulled alongside; one man hauling and possibly helping with unloading, and one man unloading. The power required would consist of one two-plow tractor on the harvester, a one or two-plow tractor on the blower, and a small tractor or horses, and three wagons for hauling, unless a very short or long haul is necessary.

The Blower. Considerable experience has been secured with blowers. This experience shows clearly that the design of the blowers used with field ensilage corn harvesters is mostly all wrong, including the arrangement of the feed table with respect to the blower and belt. One of the most important observations is that the intake opening should *not be* at the *center* of the fan housing.

Several of the engineers are fully convinced at this time that the proper layout of the blower and feed table would correspond to that of a typical cylinder type ensilage cutter, using a feed table about 8 ft long. Thus the load would be driven up alongside the feed table and pitched off to the side, similar to the arrangement of unloading bundles at a threshing machine; dropping the side of the rack box or opening a large door in the middle of the sideboard would make unloading very easy. At least one such blower has been built and was very satisfactory. A leveling roll operating in the opposite direction of a feed roll and at fixed height eliminates the need for a man at the feed table.

It is important to avoid using too small a blower pipe. Probably 7½ or 8 in is about the smallest size for most successful operation.

I have noted a tendency toward equipping small combines with power plants; now a power plant is needed for the blower used with grass silage, etc. A very fine arrangement would be to use the power plant on the combine and on the blower. This would make a very compact, efficient unit of the blower. Only two tractors would now be needed to operate the system, one for operating the forage harvester and one for hauling. This power plant might perform the following jobs: (1) Operate the blower when putting up grass silage, dry hay, straw, and corn silage, (2) operate the combine, and (3) grind feed.

Wagons for Hauling. Experience so far indicates that a flat bottom hay rack, 8x14 ft with sideboards 3 ft high is very satisfactory for grass silage. For unloading into the blower described above, doors about 7 ft long in the center of the sides would be convenient. Grass silage will weigh 18 to 25 lb per cu ft in the wagon.

For dry hay the sides should be 6 to 7 ft high. With the combination elevator and blower used on the Allis-Chalmers machine, it is desirable to cover the box with some light but cheap and durable cloth. One operator made bows for the top by soaking thin willow boards in water. With correct design of the blower-elevator flight and the hood, such a covered wagon can be filled without a man on the load.

FEATURES OF SMALL GRASS SILAGE HARVESTERS

A summary of the developments to date indicate that the 1941 machines in the small class, which includes all except Fox and Eagle, will be about as follows:

Cut. Most of the machines will be left-hand, one right-hand machine has already been changed to left-hand. This "hand" is important for the convenience of the truck driver when using trucks for hauling in connection with a side-delivery elevator on the harvester.

Width of Cut. Machines this year varied from 36 in to 48 in, but next year's models will be 40 to 48 in wide.

The Reel. A power-driven reel seems advisable, and at least three of next year's models are being designed with this type of drive. The reel should provide vertical adjustment from the tractor seat, and similar fore-and-aft adjustment is desirable. To E. W. Hamilton is credited one of the most valuable improvements in reel design, namely, the solid reel bats, that is, a solid surface from the shaft to the periphery. On the experimental machine used this year, ¼-in mesh hardware cloth was used; solid galvanized iron, corrugated to provide stiffness, would be better. This successfully handles a combination of short material, for example, soybeans mixed with tall material such as sudan grass.

Weight. The small experimental machines weigh about 1400 to 1500 lb.

Guards. Heavy guards similar to mower guards and mounted approximately parallel to the ground, when in the "low" position, seem best.

Outside Divider. This should be as narrow as possible with no gather.

Length of Mower Knife. This should be long enough to extend through the outside divider at all times.

The Draper. Especial care must be given to the design of anti-wrap guards at the sides of the draper canvas to prevent material from getting inside and wrapping on the rollers.

The Feed Rolls. Limiting the lift of the feed rolls to not over 2 in (1¼ to 1½ in may be enough) keeps out rocks larger than this dimension. The rolls should operate very close together when the top roll is in the bottom position, and with sufficient tension to prevent material slipping through, as this will result in uneven cutting and, what is more serious, apparently cause a considerable increase in power required by the cylinder. One machine uses a bottom feed roller of steel and a top feed roller covered with a thick layer of rubber. Considerable tension is maintained between these rolls, with the result that rocks are almost entirely excluded from the cutting head.

It seems likely that the upper feed roll may have to be different for grass than for dry hay and straw. It should therefore be easily removable. It has been suggested that this machine will be an excellent "canning pea" harvester, and for this purpose the entire cylinder and probably the upper feed roll would be removed.

The Cutting Head or Cylinder. A wide variety of designs are being used but some elementary principles seem to be established. The cylinder is usually 36 in wide and is equipped with three or four knives with speeds varying from 1000 to 1600 rpm. The knives are spiraled one-third for a 3-knife and one-fourth for a 4-knife head. The length of cut for grass silage should be short (that is, ¼ to ½ or ⅝ in), while the length of cut for dry hay *must* be long (1¾ to 2 in) in order to secure satisfactory keeping qualities and to reduce the dust nuisance. Therefore, it is necessary to be able to change the speed of the cutter head, change the number of knives, or change the speed of the feed mechanism.

There is a strong tendency for material to accumulate inside the cylinder to the point where it probably increases the power; very narrow knives reduce this tendency. A knife design which provides a shearing action similar to that of a metal shear seems to hold an edge better than the conventional type of knife used on cylinder type ensilage cutters.

The Conveyor. Side delivery and rear delivery are available, and it seems likely that eventually all machines will have to provide both types. Trailing the wagon behind the harvester provides an outfit that is easily handled and controlled, whereas hauling the wagon alongside with a separate power unit requires constant vigilance of both drivers, and, even so, some material is usually spilled due to the wagon being out of position, and minor collisions also occur. If a truck is to be used for hauling, then the machine must have side delivery. Most of the operators have expressed a preference for the rear delivery with a trailed wagon.

For handling green material, an elevator seems best; for dry, a blower would probably be best, for with this arrangement the wagon could be loaded without having a man on the load.

MACHINE SHOULD ALSO HANDLE CORN

Corn Harvesting Attachment. To me one of the most vital developments is an attachment for converting the forage harvester into an ensilage corn harvester. I understand that some field trials were conducted this fall with such an attachment, with what success I do not know. The important thing this year has been to develop the basic machine. The machine will chop corn for ensilage; it can be developed into a stationary ensilage cutter we know, and some of us believe a satisfactory attachment can be developed so that the machine can be used as a field ensilage corn harvester, but this may not come for a year or two.

(Continued on page 17)

A Head Thresher for Plant Breeding Studies

By June Roberts
MEMBER A.S.A.E.

AGRONOMISTS engaged in plant breeding need a machine for threshing small samples of wheats, sorghums, and grasses. The requirements for such a machine are simplicity, ease of cleaning, durability, and portability. From the agronomic standpoint the primary requisites of this machine are that it thresh the grain and that there be no possibility of mixing the samples. This requires a machine which will not throw the grain into the air and within which there is no place where there is a possibility of the grain lodging.

In developing a thresher to meet these requirements, a design using two steel pipes was selected, the smaller one serving as the cylinder and the larger one as the concaves and framework. For the cylinder a 5-in heavy steel pipe was selected, and for the concaves, an 8-in heavy steel pipe. Second-hand pipe worked very well as it was necessary to machine each pipe to insure proper balance and smoothness. Cast iron end plates were used on each cylinder to insure tightness and cylinder balance. The clearance between the end plates of the large and small cylinder was 1/64 in. This close fit prevented grain from sticking between the end plates.

Teeth for the cylinder and concave were made from ¼-in steel cap screws, the length depending upon the location. The location and spacing of the cylinder and concave teeth are shown in Fig. 1.

Speed changes were secured by V-pulleys, both the three-step and four-step 4-in V-pulleys proving satisfactory. Using the three-step V-pulley, speeds of approximately 900, 1800, and 2700 rpm were secured when the thresher was operated by a 1750-rpm electric motor. The four-step V-pulleys, when operated by the same motor, gave speeds of approximately 800, 1200, 2700, and 4000 rpm. Costs of the three-step and four-step pulleys were nearly the same; therefore, the four-step pulley was recommended. The most satisfactory speed for a given grain depended somewhat on the condition of the grain, the variety, maturity, and moisture content. For average conditions, cylinder speeds of 800 to 1200 rpm have proved satisfactory for grain sorghums. These speeds gave peripherial speeds for the cylinder teeth of 1500 to 1900 fpm. Speeds for wheat had to be increased from 1200 to 2700 rpm, giving a peripherial speed varying from 1900 to 5100 fpm. For alfalfa and some grasses the speed had to be increased. It was found that 4000 rpm was sufficiently high for all material threshed.

The plain cast iron bearing was found to give excellent service; however, if the end plates were inferior and the castings had blow holes, ⅛-in brass bushings were inserted.

The opening in the hopper has been kept relatively small to prevent slugging the machine, and for safety. With a small opening there was much less chance of getting a hand caught in the cylinder. While feeding with the small opening and the long hopper there was little danger.

The unit was driven by a ¼-hp electric motor operating at approximately 1740 rpm. The power requirement of this thresher varied from 0.12 to 0.40 hp depending upon the speed and load. The cylinder is relatively heavy, thereby preventing any great variation in the power requirement when feeding.

Fig. 2 shows the head thresher handling samples of wheat. The material is fed into the machine until the heads are gleaned, the straw being pulled back and thrown away. It is necessary when using this machine to clean the grain from the chaff by a fan or by air pressure.

Fig. 3 shows the machine equipped with a 12-in electric fan which furnished air for cleaning. This attachment, when properly adjusted, did an excellent job of cleaning when threshing wheat and grain sorghums; however, this method has not been satisfactory for some of the light grass seeds. Only a small amount of additional equipment was required for the cleaning apparatus. Galvanized steel 30 in long was formed into a semicircular trough with a 12-in diameter at the large end and 8-in at the small end. The angle of the trough should be regulated for each type of grain. By means of a chute the (Continued on page 32)

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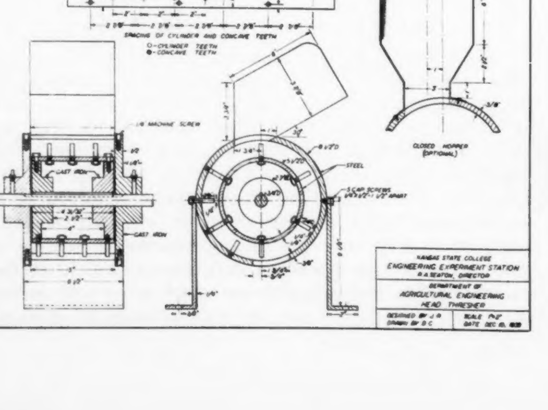
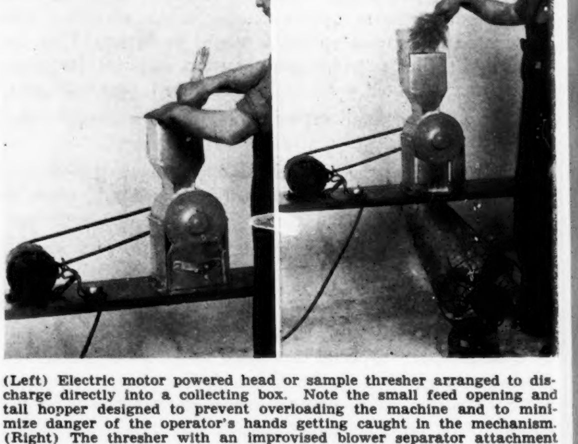




(Left) Electric motor powered head or sample thresher arranged to discharge directly into a collecting box. Note the small feed opening and tall hopper designed to prevent overloading the machine and to minimize danger of the operator's hands getting caught in the mechanism. (Right) The thresher with an improvised blower separator attachment

Metal Sheets for Roofing, Siding, and Ceilings

By Ray Crow
MEMBER A.S.A.E.

STRUCTURAL materials have been fiercely competitive since the manufacture of many of these items was taken over by industry. In the low-cost structural field, including farm buildings, the initial cost often must take precedence over long-range economy. It is difficult to merchandise a structural item at a higher price, on the basis that it will be cheaper in the long run than one which now serves a similar purpose and perhaps has done so for many years. Each sale must be an individual transaction, which adds so much to the cost of the item that it results in low production. Volume in any industrial production is necessary to develop low costs of manufacture.

Farm building construction always has been basically of wood, and probably it will continue so to be, more or less indefinitely. The greatest inroads made so far, by competitive materials, have been for the purposes of roofing. But, for the most part, the erected initial cost has been greater, and therefore the merchandising of these items has been handicapped.

However, due to technical and manufacturing improvements in many other materials and combinations of materials, together with a somewhat growing scarcity of good quality lumber, this situation has now changed considerably. In certain sections of the country, metal roofing sheets have largely supplanted other materials for rural construction. For many types of industrial and commercial use, galvanized steel sheets for siding, as well as for roofing, have given economical and satisfactory service for many years. I only need to call your attention to the vast number of manufacturing plants, warehouses, machine shops, and other buildings so constructed to confirm this fact.

Some years ago our company began research and experimental work along the line of using formed steel sheets for siding and ceiling purposes, as well as roofing, in the erection and rehabilitation of tenant dwellings for its employes. The results were so satisfactory from the standpoint of economy, appearance, and apparent general satisfaction that considerable extension of the use of these materials has been made in our trade territory on a commercial basis. Efforts along this line have been to encourage the use of a combination of various available building materials where each would serve the purpose best. In the Southeast reasonably good framing lumber is relatively plentiful and comparatively low in cost. However, the price of good quality novelty or resawed siding has been increasing rapidly during recent years.

It is hazardous to discuss competitive building material costs in dollars and cents, except in some one locality where all unit prices involved are well known. Regardless of the care taken in explaining that such figures are indicative only and that local unit prices must be substituted to derive local relative costs, one may be called on to make good in some location where the prices and adaptability of a certain material are out of line with those shown in the comparative estimates.

At the time of preparing this paper, the retail price per net square of galvanized steel 28-gage weatherboard siding in my home town, Birmingham, Ala., was considerably less than that of 100 board feet of ¾-in No. 1 grade novelty wood siding. The metal siding sheets have a net covering width of 24 in, and therefore a square will cover 100 sq ft, less possibly 3 per cent for end lap on large areas. On the other hand, it requires 120 ft or more board measure of 6-in tongue-and-groove wood siding to cover a net of 100 sq ft. Metal siding comes in sheets 2 ft wide and in stock lengths by 1 ft variations from 5 to 12 ft, and weighs less than 1 lb per sq ft. These large sections with light weight, yet so formed that the crimps give them rigidity and strength, favor a lower cost of application than is the case of materials in smaller units and heavier weight per unit. This factor also enters into the lowering of transportation costs.

Steel weatherboard siding sheets can now be obtained in the ordinary gages used, with a special primer coat of metallic paint baked on in the factory, at a cost of about 70 cents per square premium over the plain galvanized sheets. This is considerably less than the cost of applying a primer coat to any structural material surface in the field. It also makes an excellent base for a field finish coat and largely solves the problem of painting newly manufactured galvanized sheets.

Where extremely low cost is a paramount factor and appearance is not so important, the galvanized metal siding can be left unpainted for a period of anywhere up to 5 or 6 years or, at any rate, until most other materials would need repainting, as far as protection is concerned. This reduces the initial cost by the amount required to paint other material for immediate protection. After weathering it can be painted satisfactorily with any good outside sun-resisting paint.

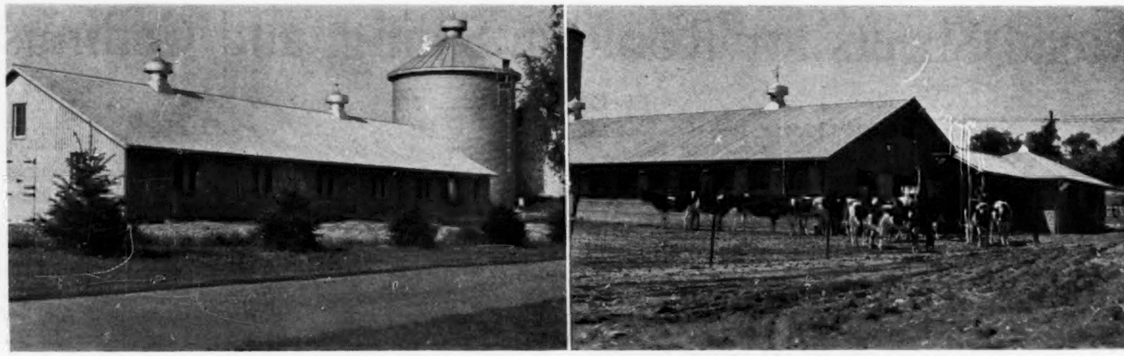
The National Bureau of Standards has made a number of investigations as to the life of various types of painting for galvanized sheets. It reports that, with the proper material, one coat applied each 5 to 7 years generally will maintain the surface in good condition.

It may be noted in this connection that, since steel is nonporous, there is no absorption of paint into the surface; therefore, the same quantity of paint will go considerably farther than on most other materials. Also, due to the uniformity of the surface in color and texture, two coats of paint will usually give a finish equal to that obtained by three coats on more porous materials. All of these matters are factors in the economy of the use of sheet steel weatherboarding.

ADVANTAGES FOR INSIDE CEILING

For inside ceiling purposes, the merits of beaded metal sheets are even less known than for outside use. This material comes either zinc-coated or painted on both sides with a metallic paint baked on in the factory. The latter is approximately $1.00 per square lower in cost than the former for the same gages ($1.70 per square lower than the primed galvanized sheets), and the indications are that it will give entirely satisfactory service when not exposed to the weather. The painted surface is an excellent base for

Presented before the Farm Structures Division at the Fall Meeting of the American Society of Agricultural Engineers at Chicago, Ill., December 3, 1940. Abridged. Author: Engineer, sales promotion division Tennessee Coal, Iron, and Railroad Co.



Two views of steel exterior surfaces for animal shelters and feed storage buildings

further painting, or it can be left as furnished if desired. In any case, the result is a noncombustible surface that is vermin proof, has a good appearance, and is extremely sanitary. As to the matter of economy, the same factors apply to this material as have been mentioned with relation to the galvanized steel sheets for outside purposes, with the additional advantages of lower initial cost per square of covering surface.

The use of metal sheets, for both inside and outside purposes, has many advantages other than that of initial and long-time economy. Lower fire hazard is extremely important, particularly for rural construction. With a wood frame, wood floor, and other wood parts in any structure, the steel sheets will not make it entirely fireproof. However, this incombustible envelope will prevent fires catching from most outside or inside sources, and will radically retard the progress of fires that do occur. Properly grounded, this construction gives practically complete protection from fires caused by lightning. Another point already mentioned, but worthy of repetition, is the sanitary surface. This can be cleaned easily and readily at any time, does not hold dust, and will not absorb dirt or germs. This point is important in such structures as dairy barns, milk houses, and similar buildings, as well as for residences. Another point is that snow loads will not build up on metal sheets to the extent they will on surfaces of rougher texture.

The thermal conditions of structures erected as outlined do not differ materially from those erected from more commonly used materials. It is true that a thin metal sheet is a somewhat better conductor of heat than is a one-inch board, but in any uninsulated structural wall, the adjacent air films and enclosed air spaces, rather than the materials themselves, largely make up the insulating value. However, the steel sheets in the combination are nonporous and the tightly lapped sheet joints are 2 ft apart; therefore, the infiltration of air and moisture is almost entirely precluded. Actual tests indicate that this property fully offsets any practical difference in the insulating value of wall materials ordinarily used.

As an example, tests made by the Battelle Memorial Institute of Columbus, Ohio, show that the overall air-to-air thermal conductance, or *K* factor, of two light-gage steel sheets, with an air space between, with a 15-mph wind blowing against the exterior of one sheet and with no other insulation or structural material of any kind, is 0.36. This compares with a similar factor of 0.25 for asbestos siding over wood sheathing, with building paper between, on the exterior, and lath and plaster on the interior of an air space, at a cost probably twice as great. As another comparison, the thermal conductance of a 13-in brick wall plastered directly to the interior face is given as 0.34, or practically the same as for the two steel sheets and air space.

It is thus evident that there is no real merit to the contention that metal sheets in proper combination make a structure hot in summer and cold in winter. The temperature within any uninsulated structure tends to approach that outside as the latter temperature changes. Massive structural materials, such as masonry, will slow up this tendency somewhat by absorption and temporary retention of the heat or cold as the case may be, thus causing a lag. This absorbed heat or cold must be given up as other changes occur, which frequently and materially affect the comfort factor in a building. We all know, for instance, that an uninsulated masonry building will continue to throw off heat far into the night after a hot day, or stay cold far into the morning after a cold night. Lighter materials permit a more rapid change.

CONDENSATION PROBLEM HANDLED

Condensation or sweating is another objection often mentioned in connection with the use of steel sheets. This developed from the fact that, under certain combinations of humidity and temperature inside and outside of a single thickness of metal, condensation of moisture will appear. There must be sufficient differences in temperature to produce what is known as a dew-point condition. The air on the warm side must be humid and must come in direct contact with the metal surface. Building felt or similar materials applied next to the sheets on the warm air side will eliminate this condition. However, the fact that thousands of acres of a single thickness metal are used for roofing and siding for important manufacturing and commercial buildings throughout the country, as mentioned elsewhere, is rather conclusive evidence that this condensation is not a serious factor.

In a structural wall with air spaces or porous insulation, the use of steel sheets on the warm and moist side is one of the best known methods of reducing or entirely preventing condensation within the wall. It is agreed by all authorities that a moisture barrier in this location is essential for that purpose, and steel, no matter how thin, serves this purpose absolutely. In addition, it furnishes a presentable, long-lived, sanitary surface. Moreover, it is easily decorated.

Another extremely important phase of construction work to which steel sheets are admirably suited is that of rehabilitation of old structures. If the frame is reasonably sound, the application of these sheets over the old roofing, siding and ceiling materials practically transforms the building. It becomes new in appearance, much more fire-resistant, and the thermal conditions are improved. The rela-

tive economy of this type of rehabilitation, compared with conventional patchwork repair methods, depends on the condition of the old surfacing material.

Speaking very generally, we find that if as much as 15 to 20 per cent of the area of old covering materials must be replaced, and particularly if this occurs in several locations, the initial cost of placing the steel sheets over the entire surface approximately equals that of patching up the original surface. If a greater percentage of the old surface needs renewing, the comparative initial cost of the steel envelope will be correspondingly less.

As a matter of fact, our experience in this type of operation shows that many frame buildings can be economically rehabilitated by the use of metal sheets, particularly those which have deteriorated to the point where new structures would be cheaper than repair operations by conventional methods. The cost of repairing the foundation, squaring up and plumbing the frame, renewing decayed window sills, sash, exterior trim, and other parts that will remain exposed, will be the same, whatever method of rehabilitation is used. After these things are done, however, unless considerable sections of the old surfacing materials are entirely decayed, resurfacing with steel can be done by renailing loose boards, removing any obstructions, covering the old surfaces with building felt, and applying the metal sheets in accordance with instructions furnished by the manufacturer.

One point in favor of this method of "face lifting" is that the total cost usually can be estimated much more closely than that of conventional patchwork repairs. In the latter case, it is usually found that when the decayed portions are torn into, they extend much farther than originally thought. Then the labor of fitting in sections and parts and getting the patches finished so as to be as little noticeable as possible, is relatively more expensive than solid new work. Further, if a part of the surfacing must be renewed, the balance probably is well on the way to the same condition and within a few years other patches must be made.

ADDED LIFE FOR OLD BUILDINGS

The metal sheets, when properly applied, seal the frame and old surfaces from the entrance of further moisture, protecting them indefinitely. Many cases can be cited in our own repair work where, at the expenditure of one-third to one-fourth of the renewal cost of an old weather-beaten, ramshackle dwelling slated for tearing down, we have remade it into a neat, new appearing structure with a longer and more economic life than it had when new, because of the lower maintenance cost built in. Our costs for such complete rehabilitation run from $50 to $125 per room, depending on the general conditions of foundation, frame, windows, and porches; and whether all surfaces, both outside and in, require recovering. For only the sheets and application, the cost runs from $20 to $25 per room for weatherboard siding, $12 to $15 for roofing sheets, and $40 to $50 for the inside and overhead ceiling sheets. There is usually two and one-half to three times as much inside and overhead ceiling area as side wall. Frequently not all the rooms will require recovering inside, but almost always kitchens, bathrooms, halls, and other rooms with severe service can be economically treated in this way.

The life of the sheets used in this service depends on the quality of the protection given to and maintained on the base metal. Iron or steel kept dry, either by waterproof coating or location, will last indefinitely. Commercially pure zinc in the form of galvanizing is by far the most extensively used material for this purpose, because of its efficiency and low cost. Terne, an alloy of lead and tin, is used to a lesser extent, and with proper application any good waterproof paint renewed sufficiently often will serve the same purpose. This is indicated by the thousands of tons of exposed structural steel, such as bridges, which have no other protection over periods of a full lifetime.

However, the cost of continued field painting for the protection of base sheet metal is much greater than for factory galvanizing. The life of the latter depends on the thickness and uniformity of the coating applied. No definite life period can be assigned to any particular installation unless all factors are known. We find that a considerable percentage of the galvanized steel sheets now in use as roofing, which receives much harder service than does siding, have served 20 years or more with no painting or maintenance. Unfortunately, some installations begin to show corrosion in a much shorter period. This means that protective painting should be given the galvanized surface earlier than would otherwise be necessary.

Metal roofing, siding, and ceiling sheets, when judiciously combined with other commonly used building materials will result in structures that are not only lower in initial cost but also have many additional advantages. Among these are lower fire hazard, reduced maintenance and amortization costs, complete protection from rodents and vermin, neat trim appearance, excellent thermal conditions, and first-class sanitation.

New Developments in Forage Harvesting Machines

(Continued from page 13)

THE HAY HARVESTER IN MACHINERY MANAGEMENT

The hay harvester should replace the hay loader, the hay fork equipment in the barn, and the ensilage cutter. Using average suggested prices, we have the following relative investments between the new and the old equipment:

New Equipment (Hay harvester)	
Hay harvester	$350.00
Pick-up attachment for dry hay	35.00
Blower with molasses pump	100.00
Ensilage corn attachment (for stationary work)	50.00
	$535.00

Old Equipment (Basis of grass silage equipment)	
15-in ensilage cutter with molasses pump	$400.00
Green crop hay loader	170.00
Hay fork and equipment	60.00
	$630.00

Old Equipment (Basis of dry hay and ensilage cutter for corn only)	
12 or 13-in ensilage cutter	$320.00
Dry hay loader	135.00
Hay fork equipment	60.00
	$515.00

If the field corn ensilage attachment can be developed satisfactorily at a cost of possibly $100, this then would give the following:

Hay harvester	$350.00
Pick-up attachment for dry hay	35.00
Blower with molasses pump	100.00
Field ensilage corn attachment	100.00
	$585.00

However, if the field corn attachment can be developed, then the corn binder costing $225 to $250 could be dispensed with on many farms. This would increase the value of the displaced machinery to about $755 to $870.

Seed Corn Grading in Relation to Planting

By A. H. Wright

THE introduction and extensive use of hybrid varieties has given rise to a difficult seed corn grading problem. Not only are there innumerably more varieties, but the variations in the seed size and shape of the hybrids are incomparably greater than those of open-pollinated varieties. A composite of the seed of the varieties used in Wisconsin alone has a variation of 24/64 in in length, of 24/64 in in width, and of 24/64 in in thickness. This of course includes all seed—the flats, thicks, and rounds. Also, the seeds possess ridges and depressions; they are lopsided, angular, and wedge-shaped. Another thing, the need for accurate planting is greater in corn than for any other important crop. A few pounds must plant an entire acre in either hills or drills, and the stand must be uniform. Now, added to all this, is "eye appeal" created by high-pressure sales propaganda.

Anyone who tackles the seed corn grading problems must, I believe, consider (1) the needs of farmers who plant the seed—the degree to which accuracy of planting is useful to farmers, (2) the planting equipment—planters and planter plates now in farmers' hands or now available to them, (3) the grading equipment that is now available to seed corn producers, and (4) the appearance (eye appeal) of the seed.

In attempting to work out a set of standard grades for Wisconsin, we have tried to serve the immediate needs, meaning that we must have grades that can be planted with the present planting equipment, with planter plates now in use; also that we must have grades that can be made on the grading equipment that is now available. We have not attempted to set up ideal grades on the assumption that the necessary planting and grading equipment would be immediately forthcoming. We believe, however, that in consideration of future progress, methods of attack other than we have used should be considered.

FACTORS INFLUENCING NUMBER OF GRADES

It is our opinion that, for the present at least, grading cannot be simplified; that to handle the varieties of any one state a rather large number of grades is necessary. In setting up a set of standard grades for any one state or region, all of the varieties used in the area must be included. Thus in Wisconsin we must consider the very short, relatively broad-seeded varieties used in the north and the very long, narrow-seeded varieties used in the southern counties, and also the varieties having seeds of intermediate size and shape.

In addition to variations that obtain in the kernel size and shape of the various varieties, it is also necessary to consider the variations that obtain in available planter plate equipment. If there were but one style of planter and it combined every good feature of all planters, and if a complete range of planter plates were available for such a style of planter, then much simplification of grades could be accomplished, but it would still be necessary to have a considerable number of grades.

There is another way to reduce the number of grades. Simply discard those sizes and shapes of seed that do not conform with the grades that comprise the bulk of the seed produced. If all narrow seeds (those less than 17/64 in in width), all short seeds (those less than 20/64 in in length), all extra large seeds (those more than 26/64 in in width), and all round seeds regardless of size and shape were discarded—used for feed instead of seed—then the number of grades would be reduced to less than 40 per cent of those now used. This sounds interesting, but we do not expect it to be done because good crops are obtained from off-sized seeds and the price is relatively low. We are of the opinion that farmer demand will determine what grades, if any, will be discarded. In the meantime, we are obliged to include all sound seed, regardless of size, in our grading plans and standards.

AREAS AND VARIETIES AS BASES OF GRADING

Some believe that grades must vary according to the variety of corn and that a set of standard grades is not applicable to a large group of varieties, also that if accurate grading is to be accomplished, each variety, or group of similar varieties, must be graded according to its own peculiar (specific) seed make-up. Others contend that satisfactory standards can be set up which will apply to all varieties of any one state and probably to larger corn-growing areas. Our experience indicates that standard grades for Wisconsin can be set up and successfully used, regardless of the variation in the varieties that may be involved. With the help of seed corn producers, we have worked out a complete set of standard grades for Wisconsin. This set provides for all sizes and shapes that are capable of producing a satisfactory crop of corn and for all varieties of seed produced in Wisconsin. The set includes 19 grades. The approximate dimensions for each grade have been established, including length, breadth, and thickness. Also, planter plate suggestions have been worked out for nine different makes of planters. In addition, a grading scheme or "seed flow" for making the grades has been provided and a detailed description of each grade has been prepared.

We are not suggesting that any attempt be made to devise standard grades for any group of states, such as the corn belt, or for any other region. We have tried only to help serve the urgent and immediate needs of our own state. We admit frankly that we are not perfectly satisfied with what we have done, but we hope for much future improvement.

Since seed corn has length, breadth, and thickness, and since each of these dimensions is related to planting accuracy and to planter plate design, it is necessary to plan the separation of seed according to all three dimensions. Length grading is new, but fully as important as width and thickness grading. Equipment for handling each dimension is now available.

Our grading scheme provides for three lengths of seeds. This does not mean that the seed of any one variety should be separated into three lengths, but that if a composite were made of the seed of all (Continued on page 24)

Presented before the Power and Machinery Division at the fall meeting of the American Society of Agricultural Engineers at Chicago, Ill., December 3, 1940. Author: Professor of agronomy, University of Wisconsin.

(EDITOR'S NOTE: Additional information on grading suggestions, Wisconsin standard grades, grade dimensions, screen grading arrangement, and planter plates suggested for Wisconsin standard grades can be obtained from the Seed Corn Office, Agronomy Building, University of Wisconsin, Madison, Wis.)

Farm Earth Moving as Applied to Pond Building

By W. A. Harper
MEMBER A.S.A.E.

A SHORTAGE of water for livestock, or irrigation, can be and is being remedied on many farms by ponds. Pond building fits into local and national schemes for the conservation of resources by checking erosion, retarding runoff, and raising water tables.

Upon deciding to build a pond, one must arrive at a design, investigate materials available, and provide ways and means of doing the construction work. Earth moving makes up the principal portion of construction work. Other portions may include land clearing, paving, riprapping, installation of water conduits, seeding, and the like.

No two states have precisely the same state laws and regulations affecting the construction of dams. Obviously design and procedure should conform to local legal requirements.

This paper deals principally with earth moving. Mention is made of design, materials, and other construction operations only as they apply to the main topic. Currently available publications on the general subject of farm ponds are listed at the end of this paper.

A good earth dam is a great deal more than a mere pile of earth. It is impervious. Heavy local rains will not damage it. It should be built at the least possible cost consistent with its permanent function of storing water. As simple as these requirements are, they are not always easy to meet. Many failures are traceable to a compromise in design features because of difficulties or costs of construction.

After determining the location for a pond and of a dam, the engineer designs the details of the dam itself. The pile of earth, known as the dam, is designed from the top downward. Two of the first items decided upon are the height of the dam and width of the top. From here, the slopes are layed in.

But the bottom of the dam is constructed first. The supervising engineer must disassemble the principal design features and reassemble them in reverse order. Ordinarily, the first equipment operation is to clear the dam site, the area for the dam foundation and for the borrow pit. After disposing of trees, plant growth, and the like, there may be a layer of top soil that should be removed. The top soil may be stored and later spread over the areas that are to be seeded after construction is completed. Another purpose of removing the top soil is to provide a better water seal between the fill and the clay subsoil. This is a necessary feature for many soils.

Presented before the Soil and Water Conservation Division at the fall meeting of the American Society of Agricultural Engineers at Chicago, Ill., December 5, 1940. Author: Superintendent of proving grounds, Caterpillar Tractor Co.

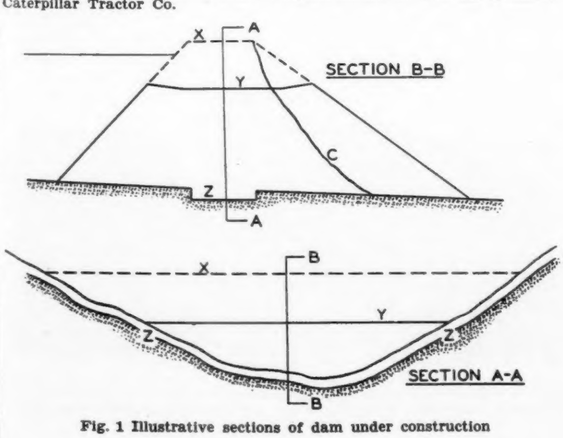


Fig. 1 Illustrative sections of dam under construction

The area on which the dam is to rest should be prepared further by making the surface irregular, in order to avoid a large, smooth surface along which seepage might occur. The base for the fill should be compacted to the same density as the fill. Seepage and possible failure are further guarded against by digging a trench parallel to and directly under what will be the highest portion of the fill.

By the time these operations are completed, a more complete knowledge of soil types will be had. On many jobs there are insufficient quantities of suitable clay lying in the right places for making the dam. Less desirable material, such as sand, shale, or rocks, may have to be discarded or worked into the fill. Only first-class impervious material should be used in the center and upstream portion of the fill. When due allowance in physical dimensions has been made, a reasonable quantity of lower quality material is sometimes allowable in the other portions of the fill.

At this stage of construction, the supervising engineer can visualize the problems at hand and can make suitable adjustments in the original design, if any are needed. Fig. 1 shows two sections of a partly built dam. Both sections are through the highest portion of the dam. Section BB is at right angle to and section AA is parallel to the longitudinal axis of the dam. Dotted lines, X, indicate the finished dam. These views show that the fill has been built up to line Y.

It should be noted that the fill is higher at the two faces of the dam than in the middle. Reference will be made to this feature later. The area designated by Z is the trench directly under and parallel to the highest portion of the fill.

Mention has been made of the problem of utilizing lower quality earth in certain portions of the fill. Should such material be incorporated in the fill, it should be placed downstream from line C. This line is drawn to designate the maximum distance from the impounded water that saturation might occur. Hence the downstream portion of the fill provides weight to prevent slipping, and also it provides a leeway for line C without harmfully affecting the dam. Fig. 1 is a schematic view of a dam, and serves here to remind the construction engineer of the principal design features that may affect construction procedure.

Maximum compaction is obtained by placing the earth in thin layers and by traveling the full length of the fill on every trip. On the higher dams, the required density is obtained by using tamping rollers and by controlling moisture content.

Rotary scrapers are commonly used for making small fills. They are easily transported, investment is low, and

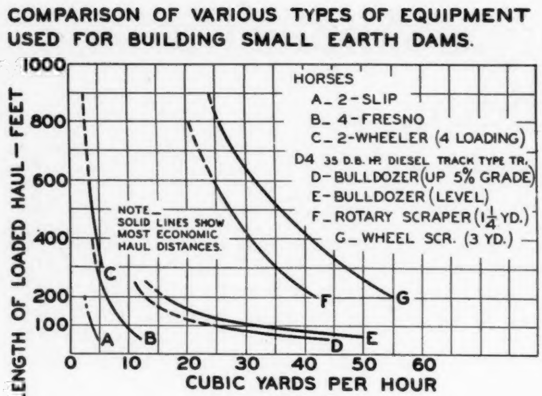


FIG. 2

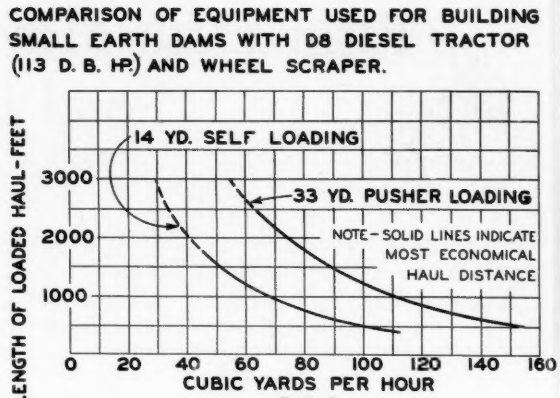


FIG. 3

they are fairly efficient. Like a plow, a rotary scraper is simple but is often incorrectly adjusted. When properly adjusted, filling takes place in a minimum of 20 ft of travel; and filling can be done at transport gear speed. Weight of earth handled in a rotary scraper is approximately 40 per cent of the weight of the tractor. Thus a 7,000-lb tractor can haul 2,800 lb of dirt at an average speed of 3 mph or more.

Wheel scrapers are more economical than rotary scrapers on longer hauls. While loading time per yard may be slightly higher, the speed of transporting is much faster. Where conditions permit the use of a larger outfit, the savings are usually quite pronounced. Weight of earth that can be loaded into a scraper of this type approximates 80 per cent of the weight of the tractor. For example, a 24,000-lb track-type tractor ordinarily loads 19,000 lb of earth. Not only does the larger outfit reduce cost, but ordinarily a better job is obtained. Earth is spread in more even and thinner layers. The operator is usually more skilled, and slopes are more often maintained at the desired angle. The heavily loaded rubber tires produce a surprising amount of compaction, particularly when the material is spread in thin layers.

With reference to Fig. 1 it was stated that the fill should be kept slightly higher at the edges than in the middle. When this is done, the outfit can be unloaded so that the earth spills the desired distance from the edge of the fill. There will be no tendency for the outfit to slide over the bank. Anyone who has loaded hay or loose bundles on a flat-bottom wagon will recognize the merit of this suggestion.

When making a cut, it is imperative that it be maintained deeper at the edges than in the middle. This is to cause the slopes to come out right. Should the middle of the cut be lower than the edges, equipment such as scrapers will tend to slide away from the banks. The result is a "ragged" slope. Should the middle become low any time during the course of construction, steps should be taken at once to remedy the situation. If not remedied at once, the situation may get out of control.

The field of usefulness of scrapers includes the construction of most earth dams. The designer might well keep in mind the principal operating characteristics of scrapers when selecting the dam site and when designating locations of material to be excavated.

When the design is completed, two important items are known, the volume of material to be moved and the distance—minimum, maximum, and average—the material is to be moved.

How should the material be moved? What equipment should be used? Actually, all sorts of equipment have been or are being used. Equipment varies as to size, source of power (men, horses, or tractors), amount of investment or rental, and availability. In addition, each piece of equipment has its individual characteristics of efficiency. Some are more efficient for loading than others; some are more efficient for transporting, etc. Unfortunately, no one piece of equipment has the best of all of these qualities. But one particular piece of equipment, or one combination of equipment, is the best compromise for any particular job.

A general idea of the earth-hauling capacity in cubic yards per hour for various lengths of haul is given in Fig. 2. Three types of horse-drawn equipment are shown. The solid line portion of each curve indicates the most economic haul distances. For example, a two-horse slip scraper (curve A) moves about 5 cu yd per hr on a 50-ft haul and 3.2 cu yd per hr on a 150-ft haul. For distances greater than 150 ft, the cost becomes so great that other types of equipment should be considered.

The second curve from the left, B, shows production for a four-horse-drawn fresno scraper. On a 150-ft haul, the latter moves 7.5 cu yd, as compared with 3.2 cu yd for the two-horse-drawn slip scraper. Should the job be a little too large for the slip scraper, the economy of the fresno is apparent.

The four-horse-loaded, two-horse-transported wheeler, represented by curve C, is more economical than either of the other horse-drawn scrapers at hauls greater than 300 ft.

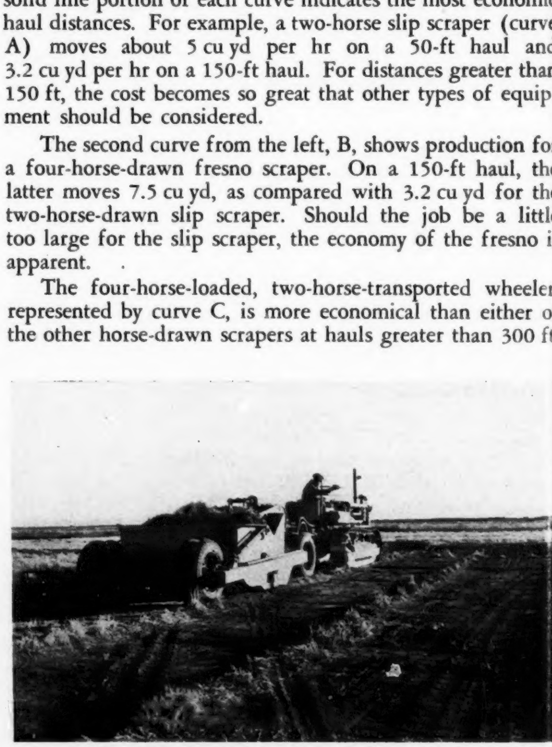
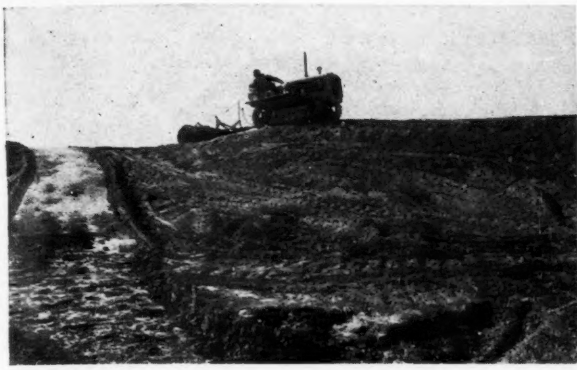


Fig. 4 A 35-hp track-type tractor removing top soil and grain stubble with a 4-cu yd four-wheel type self-loading scraper. Each pay load has a weight equivalent to approximately the available drawbar pull of the tractor or 80 per cent of the tractor weight



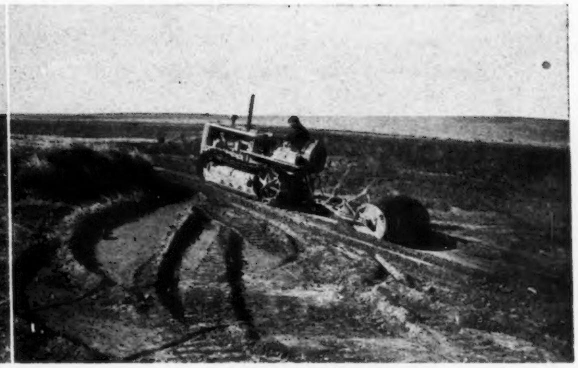


Fig. 5 (Left) A 25-hp diesel track-type tractor topping off a small dam with a rotary scraper. The earth is being spread lengthwise of the dam. Notice where the scraper cutting the edge left the ground in the left foreground, indicating good adjustment. This outfit is reported to have made this 600-cu yd fill in 22 hrs at a fuel cost of $1.52. Fig. 6 (Right) The rotary scraper is designed so that when filled there is more weight rearwards of the bowl pivot point than forward. Thus the bowl tends to rotate rearwards and the cutting edge is raised out of the ground

In fact, the wheeler moves more material at a distance of 400 ft than the slip scraper moves at 100 ft. This is because the load is transported on wheels which are more efficient than the sliding type of scraper.

These examples illustrate the principal characteristics of these implements.

Three types of equipment are shown for the 35-dhp (D4) tractor, namely, the bulldozer, 1¼-cu yd rotary scraper, and 3-cu yd self-loading, wheel-type scraper. Production capacity is shown by curve E for the bulldozer on the level, and curve D up a 5 per cent grade. The latter is shown to indicate that adverse grades seriously affect the production of a bulldozer; more so than for other types of earth-moving equipment. In general, maximum efficiency for distances of 100 to 150 ft is obtained by the bulldozer. The self-loading, carrying-type scraper is more efficient at greater distances than either of the others.

On the larger jobs, and where hauls are approximately 500 ft or greater, the larger 113-dhp track-type tractor is most economical, and on the still larger jobs two of these tractors may be used for loading and one for hauling a 33-cu yd carrying type scraper. Production capacities for these two sizes of scrapers are shown in Fig. 3. Many other sizes of tractor-scraper combinations are available, each having different production capacity.

When the volume of earth to be moved and the distance are known, these charts may be useful in selecting the type or types of equipment that may be considered for doing the job. Should these investigations disclose that the job can be done with any one of two or more types or sizes of equipment, there are certain considerations on which the final selection may be based.

Availability is one of these considerations. Any of the three types of horse-drawn equipment represents a relatively low investment. Where horses are available and the equipment is easily obtainable, these types of equipment are, and should be, used for maximum economy for small jobs and short hauls.

When distances or quantities of material are greater, the horse method becomes expensive, even though means for doing the work are available. When either of these conditions exist, a selection from the other types of equipment mentioned here becomes paramount.

The final selection will include the additional considerations of costs of setting up and cleaning up the job, operation and supervision, production per hour, and general suitability to the job.

Time limits may be another important consideration. In many instances, it is necessary to do the job quickly because of modifying circumstances. Many cases can be cited where construction was started but not finished in the same season; and in many instances failures have occurred. Once water has begun to accumulate back of a fill, no more earth can be obtained from that area. Failures may be caused by overtopping before the dam has been built to its intended height, or before spillways have been finished. Failures also may occur by reason of an inadequate seal between the

Fig. 7 (Left) Plowing before loading of small scrapers is usually a profitable practice; it permits loading at a high travel speed, and hence more earth is placed in the dam per hour. Under tough or hard ground conditions, plowing pays big dividends. Fig. 8 (Right) This job is layed out so that loading is down hill. The tractor travels lengthwise of the dam

Fig. 9 (Left) A 2-cu yd scraper operated by a 35-hp diesel track-type tractor. On the job illustrated, the average haul was 600 ft and eighteen trips were made per hour at a fuel consumption of 2 gal per hr Fig. 10 (Right) An 80-hp diesel track-type tractor is putting earth into a fill at the rate of 50 yd per hr. By loading down hill, a larger load is obtained in less time and yardage per hour is increased

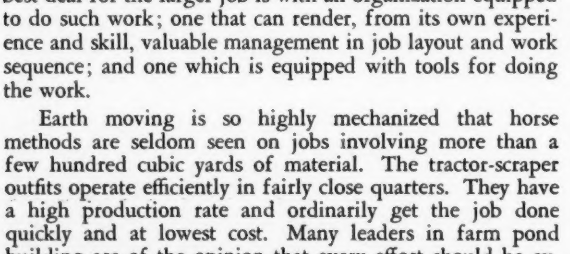
portions of the dam placed at different periods. In an attempt to shorten the construction period, while using low-capacity equipment, the dam may not be properly compacted, or properly sealed to the foundation, or of proper width to withstand water pressure. Or there may be insufficient free board. The least penalty for delayed completion is the added costs due to inconvenience caused by the impounded water and due to sealing the newer fill to the older fill.

When securing the service of the larger capacity units, emphasis should be placed on the skillful management which is commonly associated with them. Neither management nor good judgment alone can do the job. They must be properly associated, one with the other. Ordinarily, the best deal for the larger job is with an organization equipped to do such work; one that can render, from its own experience and skill, valuable management in job layout and work sequence; and one which is equipped with tools for doing the work.

Earth moving is so highly mechanized that horse methods are seldom seen on jobs involving more than a few hundred cubic yards of material. The tractor-scraper outfits operate efficiently in fairly close quarters. They have a high production rate and ordinarily get the job done quickly and at lowest cost. Many leaders in farm pond building are of the opinion that every effort should be expended to get on the job a tractor of at least 40 hp. These men know, from their experience, that outfits of this size, or larger, are most effective. These larger sizes of tractors, with suitable earth-moving equipment, are found in most communities. They may be owned privately or by townships, counties, state highway departments, or contractors. In some communities where terracing and dam building is a common practice, the equipment may be owned by the community or by a contractor who serves the community.

How much would it be worth to farmers in particular, and the country in general, if an unlimited number of dams could be built at a cost of, say, ten cents or even twenty cents per cubic yard? This question is beyond the scope of this paper. It does offer, however, a challenge to agricultural engineers. The solution of the problem of availability of modern equipment and of its supervision will give tremendous impetus to the program of building the countless small dams for which there is a market at a reasonable price.

Rental costs on the basis of a certain number of dollars per hour may seem high to the typical farmer. A 14-cu yd scraper and 113-hp diesel track-type tractor may rent for $15.00 per hour. But if this outfit moves 100 cu yd or more per hour, for example, the cost is fifteen cents or less per cubic yard. The amount of investment, or rental, that can be justified for any particular job is determined on this basic consideration.



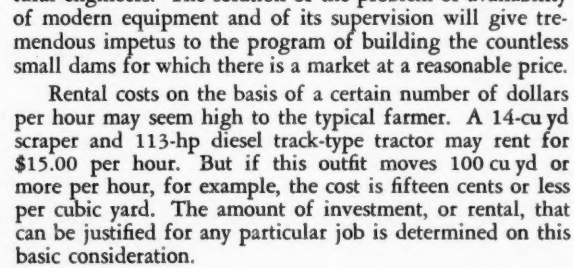


Fig. 11 (Left) The dam under construction here, when finished, will be 450 ft long and 10 ft high. It has a base of 58 ft and the top will be 8 ft wide. The picture shows the top soil being located so as to become the portion of the fill farthest down hill. The bulldozer is provided with home-made wings to permit moving earth farther without creating parallel windrows due to spillage around the ends of the moldboard. For short distances, the bulldozer has a relatively high production capacity at an exceedingly low cost. The two outfits shown working together make an excellent team. Both tractors are 35 hp and are powered by diesel engines. Fuel consumption for this type of work seldom exceeds 2 gal per tractor per hour. The bulldozer is most economical at hauls less than 150 ft and the rotary scraper at hauls of 200 ft to 600 ft. Fig. 12 (Right) This fill is being widened and made higher. The bulldozer is shown in position where the spillway might be located

Fig. 13 (Left) When this dam is completed, it will be 1,000 ft long and 12 ft high. The base is 69 ft wide and the top will be 10 ft wide. This 44-dhp diesel track-type tractor is operating a 6-cu yd scraper on an average haul of 400 ft. Production is at the rate of 12 loads or 70 cu yd per hr. This dam, now completed, is near Cimarron, New Mexico. The smoothness of the downstream slope and the roadlike top indicate that good earth-moving principles are being followed. Fig. 14 (Right) This is the upstream face of the same dam showing the ramp or roadway up the face of the dam. Once the job is layed out, it can be done at night from the tractor lights. Notice the full heaping load of pulverized material on the scraper

Dam building is an earth-moving job. Equipment found on large projects, and the splendid organization behind it, has reduced the cost of moving earth to a remarkably low figure. Anyone having a dam to build can profit by making all possible observations from these larger projects. Naturally, methods and procedures can not be adopted as a whole. But the study of these jobs will chart the course as to the best method to follow for any particular job.

Earth moving is heavy work. The earth being moved is not agricultural soil. It is the substrata which are not ordinarily handled by agricultural machines. The earth must be dug from its original position and placed in the bowl of a carrying or pushing unit. It must be transported and compacted into a mass of definite shape. That is earth moving.

When one of the larger outfits is used, a supervisor may be stationed at the cut or place of loading. His job is to direct the operators for each load. He sees that the slopes and levels are maintained. Another supervisor may be stationed at the fill. He supervises the placement of every load. He sees that slopes and elevations are maintained. When the job is done quickly, supervision costs can be justified as a profitable, money-saving investment. Supervision can not be left to the discretion of the operator. He has enough on his hands to make his machine perform at its maximum capacity. The points that can be drawn from the large earth-moving projects are that proper supervision insures more efficient operation, more yardage per hour, shorter average hauls, and less material required in the dam. These are easily translated into money values.

TABLE 1. CAPACITIES OF VARIOUS TYPES OF EQUIPMENT USED FOR BUILDING FARM PONDS OR SMALL EARTH DAMS IN CUBIC YARDS MOVED PER HOUR AT VARIOUS HAUL DISTANCES

Length of loaded haul, ft	HORSE-DRAWN SCRAPERS Slips (2-horse)	Fresnos (4-horse)	Wheelers[a] (2-horse)	BULLDOZER D4[b] Level	Up a 5 per cent grade	TRACK-TYPE TRACTOR OPERATED CARRY-TYPE SCRAPERS D4[b] 1¼-yd rotary	D4[b] 3-yd self-loaded	D8[c] 14-yd self-loaded	D8[c] 33-yd pusher-loaded
50	5.0	12.3		55	44				
100	4.0	9.4		31	25				
150	3.2	7.5		20	16				
200	2.6	6.3		16	13	42	55		
250		5.4		13	11	39	51		
300		4.7	5.3			36	47		
400		4.0	4.5			31	41	112	
500			3.95			27.3	37	101	155
600			3.5			24.5	32	92	144
700			3.0			22.4	29	85	135
800			2.85			20.5	26	78	127
900			2.60				24.4	73	120
1,000							23	68	114
1,250								58.3	100
1,500								51.3	90
1,750								45.6	81
2,000								41.1	74
2,500								34.3	63
3,000								29.4	55

[a]Snap team loading

[b]35 drawbar horsepower

[c]113 drawbar horsepower

Note: Heavy underlines in each column indicate the maximum limit of economic haul

Having met the simple requirements, before mentioned, the following engineering problems have been solved:

1 Design. Making an impervious dam that will not be damaged by heavy local rains involves many details not discussed in this paper. Design features that involve equipment operations have been considered. The designing engineer must deal with many additional problems.

2 Preparation of foundation. No building is better than its foundation. A nice-appearing superstructure may make an immediate appeal, and it may fail at the first rainstorm. A good dam is thoroughly sealed to impervious subsoil; it is keyed to its support as a further guard against water seepage and to prevent slipping downhill.

3 Equipment to do the job economically. Not only must the equipment move the earth at low cost, but the detailed requirements defined by the designing engineer must be met.

4 Profit by experience of earth movers. Farm pond building is earth moving. Earth moving has taken great strides during the past few years. Technical advances in this field can be made available to the task of building farm ponds.

5 Supervision. The large dams recently constructed are supported by the experience, research, and supervision of able engineers with tremendous resources at their disposal. While many shortcomings in design can be covered up by piling on more material, this is the wasteful method. Good design, followed up by good supervision, is the owner's best insurance. Back them up with properly selected and proven earth-moving equipment and you have a combination that will produce—is now producing—the ponds that the farmer in particular and the country in general needs.

The Farm Pond, by W. H. McPheters. Circular No. 175, Oklahoma A. & M. College (Stillwater).

Reservoirs for Farm Use, by M. R. Lewis. Farmers' Bulletin No. 1703, U.S.D.A.

Low Dams. National Resources Committee (For sale by the Superintendent of Documents, Washington, D. C. Price $1.25).

Report of Committee on Reservoirs and Ponds, 1940 — Soil and Water Conservation Division, American Society of Agricultural Engineers, St. Joseph, Michigan.

Construction of Small Dams for Farm and Community Use, by E. J. Thomas, J. N. Roherty, and H. F. McColly. Publication Department, State College Station, Fargo, N. D.

Seed Corn Grading

(Continued from page 18)

Wisconsin varieties, then this composite would require separation into three lengths. Each separate variety requires separation into two lengths only. Thus a deep (long) seeded variety will be separated into longs and medium-length seeds; a variety having seeds of medium depth (length) is separated into medium-length seeds and shorts; a variety having shallow (short) seeds is divided into shorts and discards. In this way we obtain long seeds, medium-length seeds, and short seeds. A fixed or sharp boundary line between length separations cannot be obtained with the equipment that is available, and we do not believe there is any advantage in having a definite or fixed boundary line. Overlapping of one separation into the other is consequently allowable. Each separation, however, has a minimum and maximum limit, with reasonable tolerance allowed.

In width grading we use four dimensions. These may be described as (1) narrow seeds, (2) medium wide seeds, (3) wide seeds, and (4) extra wide seeds. Overlapping of width dimensions and reasonable tolerances are allowed. Seeds of any one variety are usually composed of only three widths and some varieties have only two widths, but a composite of all Wisconsin varieties will involve four widths.

We have not attempted any work in planter box or planter plate design. That is the business of engineers. We believe that consideration of the subject is very important and that needed improvement could be made. In order to make plate suggestions for planting the various grades, we have worked with nearly all of the different makes of planters, and we have made some observations that may be of use to agricultural engineers who are interested in planter plate design. There are three more or less general types of planter box and planter plate arrangements. There is the round hole, hill-drop type which will do a relatively good job of planting poorly graded seed. There is a plate available which will plant, with at least fair accuracy, any of the 19 Wisconsin grades. The number of plates necessary for planting all grades is comparatively small. The accuracy of the number of seeds dropped per hill is not as great as with edge-drop plates and there is lack of flexibility. Because of the position of the cells in the plate, they do not change in size as a result of wear. Thus old machines will continue to plant (so far as the plates are concerned) as accurately as new machines.

EDGE DROP PLANTERS AND THE GRADING PROBLEM

Another type of planter which we may term the edge-drop or edge-selective type is represented by a large number of makes, and probably 90 per cent of the corn in North America is planted with the edge-drop, edge-selective plate. For many years the overwhelming trend in planter plate design has been towards this type. We assume that the reason for this trend has been caused by the great degree of planting accuracy that such a design provides for planting flat seeds—at least while the planter is new. The objection to this type is the tendency for the containing rim to become worn by the action of soil particles and thus the openings through which the seeds drop become enlarged, resulting in doubling of seeds. Also, if the bearing becomes worn, the plate does not turn true and the distance between the edge of the plate and the rim will vary. It is for these reasons, we assume, that old planters of the edge-drop type become inaccurate in planting. Also, in this type of planter, much special equipment is needed for planting all of the various grades of rounds and flats.

The third type may be described as the enclosed-cell, single-flat-drop plate. Our experience with this machine indicates that satisfactory accuracy can be obtained for those grades for which plates are now available. The range of plates at present is too limited, and we do not know whether cells of a shape and size can be designed for the accurate planting of the grades for which no plates are now available, but we see no reason why they cannot be designed.

We raise the question as to whether or not the trend towards edge-drop plates has been overemphasized and suggest that it may be possible to obtain equal planting accuracy and equal flexibility with planter plates which do not have the cells at the edge and which use the flat-drop arrangement.

I am sure we are all fully aware of the great burden that has been placed on manufacturers of corn planters since hybrid seed corn has come into use. Grades of every conceivable kind have been made and planter plates demanded for each kind. The situation has been extremely chaotic, and is that way still. Planter manufacturers would probably welcome grade standardization.

Farm Buildings in Land-Use Planning

By W. A. Rowlands

OUT of the discussions and deliberations of county and community land-use planning committees in Wisconsin has come a realization that (1) the repair and upkeep of existing farm structures are significant and often overlooked factors in the total cost of farm production; (2) the design and construction of farm buildings are rapidly being influenced by new crops, cropping practices, machinery, and equipment which have necessitated new methods of feed storage; and (3) the average income from existing family-sized farms in many of the newer counties is too small to provide for the maintenance of soil fertility, to furnish an adequate living for the operator and his family, and at the same time to bring in enough money for the upkeep and repair of farm buildings and machinery.

In the past many farmers have built only the traditional, conventional basement type of dairy barn for 15 to 20 cows, with an overhead feed storage for 50 to 60 tons of hay. This type of barn has cost the owner from $3,000 to $5,000. It made little difference where the plans came from, whether from farm magazines, farm equipment manufacturers, lumber dealers, agricultural colleges, or the U.S.D.A., the result has been the same—buildings often out of line with the earning power of the farm.

Economists tell us that good, complete 80 to 160-acre farms have sold for less than the replacement cost of the buildings. Engineers would, I am sure, want to compare the selling price of the farm with the depreciated value of the buildings as of the date of sale, the same as we do with automobiles. Many farmers and financiers, however, feel strongly that it is important to lower the ultimate cost of farm structures for the shelter of livestock and the storage of feed.

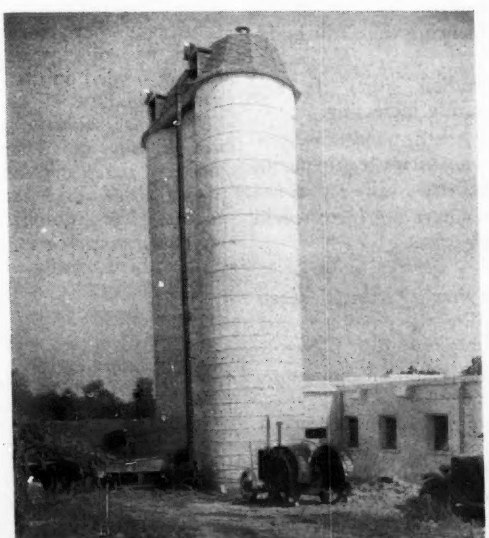
This means one of two things: either farm structures must be built at considerably reduced costs, or a more permanent, maintenance-free, fireproof type of structure must be developed. Such structures, particularly the barn, ought to be designed to permit enlargement for an increase in size of the farm business. The agricultural engineer, more than anyone else, is the one to whom farmers and farm groups must look for help in this matter. When we consider the size of this job over the entire country, it is, I believe, a real challenge to the inventiveness and ability of the agricultural engineer.

Our land-use planning committees have recognized three general groups of farmers, all with different requirements for buildings, a different financial status, and with a different philosophy and purpose in agriculture. The small settler or part-time farmer who has or is in need of additional income from sources other than the farm. Settlers in this group generally have only a small acreage of cleared land and only a few head of livestock. Their requirements for animal shelter and feed storage are not extensive. More often than not, such settlers lack the cash and must utilize their labor and the raw materials (wood and stone) on their land in the development of their buildings.

Most of the 200,000 farm operators in Wisconsin fall into the class of the man who has forty or more acres of crop land and who is gaining his entire living from his land. The big red barn, the concrete silo, the neat white house, and the mortgage are the distinguishing characteristics of the farms of this class.

Highly developed modern corporation farms, where the owners have ruled out obsolescence, and are interested in all of the ramifications of new design, new materials, and new techniques of farm operation, are putting agricultural technology to its fullest use. This group of farm operators can have a real place in agriculture in providing the laboratory where new developments in research may be tried out and studied. The farms in this class are small in number and are readily located by the battery of silos, the ultramodern, one-story, fireproof barn, the separate milking shed, and the sign at the entrance to the farm. More often than not these farms are located on a good, hard-surfaced road close to metropolitan centers where they have developed special markets for their products.

From 90 to 95 per cent of all the farms in Wisconsin are in the first two of these groups. Agricultural engineers can probably make real contributions to rural welfare by working with all three groups, but it is evident that opportunities for service are larger in the first two groups where needs are greater. The small, struggling settler and the man on the family-sized farm saddled with a heavy mortgage are the ones who need the best that the agricultural engineer can give.



During the past two years three different engineering problems in three separate county-planning committees in Wisconsin have been brought to light. These problems were of a kind which had a bearing on farm building construction, which perhaps will bring about some changes in the type of buildings erected and in the amount of money invested in buildings per farm and per acre of land. The help of the staff of the college of agriculture was solicited by the county land-use planning committees in solving these problems.

In Kenosha County, farmers recognized that, "due to changed methods of production, the average dairy or general farm is becoming an awkward unit. It is too large for one man and not large enough for two men. The minimum-sized dairy and general

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Presented before the Farm Structures Division at the Fall Meeting of the American Society of Agricultural Engineers at Chicago, Ill., December 4, 1940.
Author: State planning leader, agricultural extension service, University of Wisconsin.

farm should contain about 70 acres of plow land; 160 acres is the better-sized farm, where the equipment and labor are available."

"Acreages of arable land should be added to the awkward units," says the Kenosha County committee, "if these farms are to continue to be used for dairying and for general livestock farms. Farmers who cannot add to their arable acreage should grow more truck and other intensive crops to balance off the unit. A small acreage of plow land may limit livestock diversity, but truck crops and purebred seed production can be used to overcome this handicap."

BARRON COUNTY FARM PROBLEMS

In Barron County where land-use planning work was done in both 1939 and 1940, and where the federal land bank has extensive ownership, much time was spent by members of both county and community-planning committees in analyzing the most pressing land problems and in making recommendations for their solution.

Recently, however, at a county-wide meeting on farm management attended by some 60 people, including farmers and representatives of all federal agencies operating in the county, two days were devoted to the analysis of the business of a single farm. During this two-day period, a farm plan was prepared on one farm that would provide an adequate income for the family and permit maintenance of the land, buildings, and equipment. This farm had a gambrel-roof dairy barn, 104x36 ft. The barn was 12 years old.

As the group went inside the barn, they saw several small holes in the roof, indicating that the roof was leaking and in need of attention. All but two of the 60 people present immediately agreed that the barn "needs a new roof" and included in their plan for this farm an item of $500 for reshingling the roof. The two men who disagreed with this procedure recommended only a small sum for six bundles of shingles every two or three years. This type of repair, they felt, would make the roof last another 10 to 12 years. No agricultural engineer was present.

I cite this illustration only to indicate that we still do many things in the traditional way, often without thinking them through, and to indicate a special type of service which the agricultural engineer is best equipped to render.

The Barron County report completed in June of this year recognizes five conditions influencing the farm building problem, as follows:

1 Cost of family living, education, social life, and transportation on the farm is constantly increasing.

2 The cost of producing and marketing most raw products on the farm is increasing due to sanitary requirements, labor costs, marketing requirements, etc.

3 Prices received by the farmer have not increased in proportion to production and living costs.

4 Taxes have increased.

5 Along with the increased production costs, there has also been a serious loss of soil fertility, the replacement of which will mean additional and substantial cash outlay.

Barron County and other land-use planning committees want to know whether it is going to be necessary to increase the size of the farm, which would probably mean decreasing the number of farms, or to farm more intensively. They are asking how these increased costs are going to influence the price of land, and how the amount and kinds of machinery and equipment, livestock, and buildings will best fit a given sized farm unit. They believe this is a problem that needs study by agricultural engineers and economists.

The Barron County committee further recognized that "Rapid changes are being made in the size of farms in Barron County. In the past many of these changes have been brought about either by the clearing of additional land or the purchase of new land, both developed and undeveloped. More recent changes have involved the consolidation of two or more existing farms into a larger operating unit.

"With changes in the design, operation, and use of farm machinery, animal housing, and feed storage, it is increasingly important that capital invested in tillage and housing equipment be geared to the present needs of Barron County farms.

"All agencies of the federal government having to do with the sale of farm land or loans and grants to farmers (Farm Security Administration, Federal Land Bank and Farm Tenancy program, Soil Conservation Service, and the AAA program), should recognize that the desirable size of a dairy farm for Barron County is one with a minimum of from 40 to 60 acres of crop land, with one cow for each 5 acres of crop land, with from 30 to 40 per cent of the farm income from sources other than the dairy herd, such as poultry, sheep, hogs, and cash crops."

MARINETTE COUNTY EMPHASIZES FOREST VALUES

Marinette County in northern Wisconsin is attacking Wisconsin's problem of farm building construction from a different viewpoint. Here the effort is being made to reduce the cost of materials going into farm buildings and to provide an adequate and dependable supply of materials from which farm buildings can be constructed.

The Marinette County board of supervisors this summer added an assistant county agent, a technically trained forester, to the county extension staff. Marinette County people, in cooperation with the college of agriculture, the Wisconsin conservation department and the U.S.D.A. Forest Products Laboratory, are much interested in the development and wise use of the 200,000 acres of existing county forests in their county. They hope to see the newly developed forests utilized as a permanent and stable source of income for the people of the community. They believe that new uses and new markets can be found or developed for the wood products of their forests. They believe that the farm woods can contribute more to the farm than fuel and fence posts. They believe that a well-managed northern Wisconsin farm should have an adequate woodlot, selectively managed, which will provide all the dimension timber and finished lumber needed on the farm, just the same as a good farm garden produces all of the fresh vegetables needed. They believe that, with the passing of the large saw mills, there is a place in rural Wisconsin for the use of better designed, more accurate, and more efficient portable saw mill and planer, all of which leads to the point that the agricultural engineer has a unique responsibility in designing for the region farm structures that will make the fullest use of the farm and community woods. This will involve a consideration of the species, quantity, and dimension of the material that will be produced. It will also involve the method of preparation and preservation of materials.

Through the efforts of Duffee, Witzel, and LaRock of the University of Wisconsin agricultural engineering staff and the Forest Products Laboratory engineers, some real accomplishments have already been made in utilizing farm produced lumber, in constructing and remodeling all types of farm structures, including homes, in southern Wisconsin.

As the forest resources of the farms and the community are developed, the forester, agricultural engineer, and architect will have a real opportunity to demonstrate further the possibilities in this new and fascinating field.

Hydraulic Tests of Kudzu as a Conservation Channel Lining

By W. O. Ree

JUNIOR MEMBER A.S.A.E.

KUDZU (*Pueraria Thunbergiana*) is a perennial vine which thrives in the southeastern United States. It is characterized by prolific growth and dense foliage. Under favorable conditions, wherever a node touches the ground it will take root and a new plant will start. These growth characteristics have led to its adoption for vegetative control of soil erosion in the Southeast. It has been applied for the protection of steep fields, for gully control, for the protection of the banks of cuts and fills, and for the protection of channels in farm-water disposal systems[1]. Fig. 1 shows a typical farm outlet ditch planted to kudzu. In order to place the design of such channels on a sound engineering basis, it is necessary to evaluate the hydraulic and protective characteristics of the lining. The tests described in this paper were made to obtain the basic data needed to facilitate the rational design of conservation channels lined with kudzu.

These experiments were conducted at the outdoor hydraulic laboratory of the Soil Conservation Service, U. S. Department of Agriculture, near Spartanburg, S. C.[2]

All of the data reported herein were obtained by testing a single experimental channel at different times. This waterway was 50 ft long, had a bottom slope of 3 per cent, a bottom width of 4 ft, and side slopes of 1 vertical to $1\frac{1}{2}$ horizontal. This cross section is somewhat smaller than that of a typical field channel. (The size of the test installation was limited by the discharge-rate capacity of the laboratory). However, since coefficients for use in accepted channel-flow formulas have been derived from the data, the results can be applied to the design of field channels having similar linings.

The test channel was excavated to line, grade, and cross section in Cecil subsoil and lined to a thickness of 6 in with Cecil sandy loam topsoil. A complete fertilizer was added at the rate of 700 lb per acre. After the topsoil lining had been in place about two weeks, the kudzu crowns were planted in February 1938 on 1 by $1\frac{1}{2}$-ft rectangles in the test channel. This is a much closer spacing than is recommended in the establishment of field waterways. However, it was used in order to obtain a good stand in the test structure as soon as possible.

Three series of tests were made on the channel. The first tests were run in November, 1938. At this time the lining had been in place about eight months. Because of the heavy planting rate the cover was probably the equivalent, in density, of a good two-year stand. No frost had yet occurred so the plants were still green. The second set of tests was run in August, 1939. The channel at this time was filled with a dense mass of vines and leaves. The lining at this stage of growth had probably achieved a maximum density. The last tests were made in February, 1940. At this time the vines and leaves were dead and matted to the surface of the channel. This provided a heavy cover of mulch.

Water for the tests was drawn from the laboratory reservoir and conveyed to the experiment by means of an open canal. The discharge rate was measured by a previously calibrated flume. After passing through the rate-measuring flume, the water spilled into a forebay structure and thence flowed into the test channel. During each test the flow through the channel was held steady. Fig. 2 shows the channel during one of the tests.

The tests were made in series at the three stages of growth described before. A series of tests consisted of five to seven single steady flows ranging in rate from 1 to 25 cfs (cubic feet per second). The tests were in the order of increasing magnitude, and were separated by intervals of time ranging from a few hours to several days.

During each test transverse profiles of the water surface were made at 10-ft intervals along the channel. Bottom-surface profiles were made at these same stations before and after every test. From these measurements the hydraulic elements and the amount of soil eroded from the bed of the channel were calculated for each test. These data are presented in Tables 1 and 2.

The scour quantities shown are net figures. Some of the soil scoured from the upper reaches deposited in the lower part of the channel. This deposition quantity was deducted from the scoured quantity to give the net figures tabulated.

Protective Characteristics of the Lining. One of the functions of a vegetal channel lining is to protect the channel surface from excessive scour. The most practical measure of the protective ability of a particular lining is the maximum mean

First publication in AGRICULTURAL ENGINEERING. Author: Project supervisor, Spartanburg (S. C.) Outdoor Hydraulic Laboratory, Soil Conservation Service, U. S. Department of Agriculture.

[1]For a more detailed description of Kudzu and its application, see "Kudzu for erosion control in the Southeast," by R. Y. Bailey, U.S.D.A. Farmer's Bulletin 1840 (December 1939).

[2]For a description of the laboratory and its facilities, see "Civil Engineering" for October 1938.

Fig. 1 (Left) A typical kudzu-lined conservation channel in the southeastern United States. Fig. 2 (Right) A view of the experimental channel during a test

velocity[3] to which it can be subjected and still afford sufficient protection to the channel. This limiting velocity has been called the "safe", "allowable", "non-eroding", or "permissible" velocity. In order to arrive at an allowable velocity for kudzu, a study was made of the mean velocities existing in the channel during the tests and the resulting rates of scour. The scour data obtained are shown in Table 1.

TABLE 1. SCOUR IN TEST CHANNEL

Experiment No.	Test No.	Flow cfs	Duration, min	Scour, cu ft	Rate of scour, cu ft/hr	Mean velocity, fps
		First year — green (November, 1938)				
1	1	4.19	70	2.53	2.17	0.92
	2	9.48	100	2.10	1.26	1.82
	3	13.69	70	0.17	0.15	2.42
	4	19.47	90	0.65	0.43	2.85
	5	24.44	75	0.93	0.74	3.33
		Second year — green (August, 1939)				
2	1	2.24	60	0.499	0.499	0.55
	2	5.15	60	0.541	0.541	0.85
	3	10.13	60	0.287	0.287	1.38
	4	15.55	60	0.439	0.439	1.82
	5	21.07	60	0.592	0.592	2.28
	6	27.12	65	No data		
		Second year — dormant (February, 1940)				
3	1	1.17	41	0.053	0.078	0.72
	2	2.98	40	0.080	0.120	1.25
	3	4.92	40	1.25	1.88	1.72
	4	10.20	40	0.60	0.90	2.82
	5	15.18	41	0.99	1.45	3.35
	6	20.34	41	1.96	2.87	3.72
	7	25.19	41	2.14	3.13	4.18

An examination of the scour rates in Table 1 reveals some irregularities, but in general these rates show an increase with increase in velocity. The high rates for the first tests are probably the result of the washing out of loose material on the bed of the channel. As expected, the highest rates of soil loss were experienced when the lining was dead, while the lowest occurred when the lining was in its second-year growth.

It is realized that a number of variables may affect the quantity of soil scoured from a channel. However, for any one soil type and cover, velocity is probably the dominant factor. Since the mean velocity in a channel can be readily determined, it is the criterion of lining protective ability in general use. These tests were designed to determine the maximum mean allowable velocity by measuring the resulting scour rates for various velocities. The other variables involved were held constant in so far as they were independent of the velocity, and were considered to represent average conditions.

In selecting an allowable design velocity from these tests, a factor of judgment is involved. From a consideration of economy of design, evidently some scour must be permitted since some erosion occurred even for the lowest flows. To determine when this scour rate became excessive, a study was also made of the general appearance of the channel and the damage to the channel during each test. These studies suggest the following probable safe design velocities for kudzu:

Stage of growth	Probable safe velocity, fps
Live second-year growth	4
Dead second-year growth	2½

These velocities are suggested only for uniform channels with good stands of vegetation. For channels with sharp breaks in grade or alignment or changes in section, or with stands poorer than a good two-year growth, lower design velocities should be used. Also, for any considerable deviation from the average conditions represented by the test channel, adjustments should be made in the velocity.

[3]Mean velocity calculated as the quotient of the discharge rate divided by the cross-sectional area of the stream.

It is desired to point out here that loose mulch offers practically no protection to a channel against the erosive action of concentrated flows. The test channel had a thick cover of mulch of dead leaves and stems when it was tested in February. Most of this material was floated out by the first low flow. Some remained caught on the vines, but it was washed out in the following tests. The only protection then offered the channel were the vines rooted to its bed. The rooted vines formed a criss-cross pattern on the bottom of the channel. Since the bare spaces between the vines constituted a large proportion of the total area, scant protection was afforded by the vegetation.

Hydraulic Characteristics of the Lining. To enable the proper hydraulic design of a conservation channel, it is necessary to know the effect of the lining on velocity and channel-capacity. This effect is approximately measured by the "retardance coefficient" in a channel-flow formula. The two formulas most frequently used are the following:

$$\text{Kutter's formula: } V = \frac{41.65 + \dfrac{0.00281}{S} + \dfrac{1.811}{n_k}}{1 + \dfrac{n_k}{\sqrt{R}}\left(41.65 + \dfrac{0.00281}{S}\right)}\sqrt{RS}$$

$$\text{Manning's formula: } V = \frac{1.486}{n_m} R^{2/3} S^{1/2}$$

In these formulas

V = Mean velocity in feet per second

R = The hydraulic radius of the channel in feet (the cross-sectional area of the stream divided by its wetted perimeter)

S = The slope of the channel (the sine of the angle of inclination) if the flow is uniform; the slope of the energy grade line if the flow is accelerating

n_k = Kutter's n

n_m = Manning's n.

Since the slope term, $0.00281/S$, in Kutter's formula has practically no effect on the calculated velocity of flow in channels having slopes greater than 0.001, it was omitted in computing the values of n_k for these tests.

The values of n_m and n_k were computed for each test. These data, together with the principal hydraulic elements of the channel, are given in Table 2.

It should be pointed out that the values of n obtained from these experiments probably were influenced by the manner in which they were determined. Each flow discharged down the channel washed out some of the dead leaves and loose soil and changed the position of the vines and leaves. These changes altered the hydraulic characteristics of the channel lining from test to test. Hydraulically speaking, each test was made on a different channel. In addition, the condition of the channel changed during an individual test. However, the observational technique employed was such that the change during a single test could be detected and the data adjusted accordingly. As previously stated, all experiments were run with the tests in the order of increasing magnitude. The results obtained thus approximate the hydraulic condition at various stages in channel during a period of rising stage. If the experiments had been run with the highest flows first, different values of n would have been obtained.

To show their trend, the values of the retardance coefficients have been plotted against the corresponding values of the hydraulic radius. The diagram for Manning's n is shown in Fig. 3 and that for Kutter's n in Fig. 4.

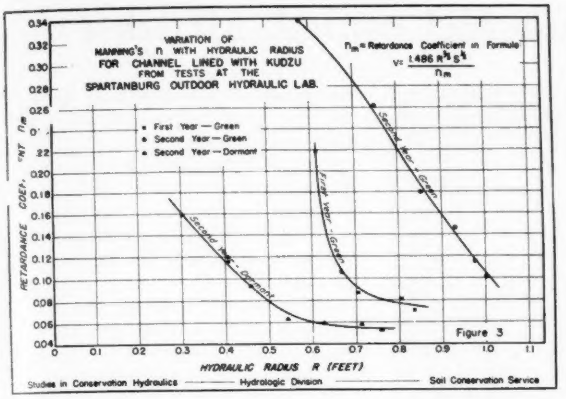


Figure 3

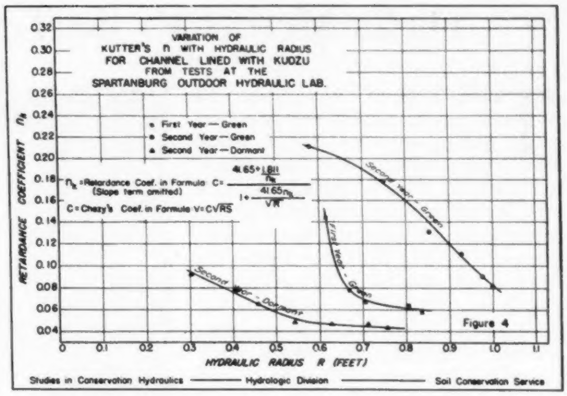


Figure 4

A study of the diagrams shows that the retardance coefficients vary with the stage of growth and with the hydraulic radius. The change in the value of *n* with stage of growth is to be expected since the density of the cover is affected. The highest values of *n* occurred when the lining was green and dense, while the lowest resulted when the lining was dormant and thin.

The reasons for the change of the values of *n* with hydraulic radius are not so readily apparent, but are presented in a paper[4] which can be briefly summarized as follows:

> When flow is shallow in a channel lined with rank vegetation, a large percentage of the total cross section is taken up by the plants. In addition, the presence of the stems and leaves in the flowing water produces excessive turbulence. The combined effect of these two actions is to produce high values of Manning's *n* and Kutter's *n*. As the depth of flow increases, the percentage of the cross section occupied by the vegetation is reduced and the values of the retardance coefficients become smaller. Also, with increase in depth and velocity, the force tending to bend the plants downward is increased. A depth will be reached where this force is sufficient to flatten the vegetation against the bed of the channel. At this point the retardance coefficients are greatly decreased because (1) the percentage of the cross-sectional area occupied by the vegetation is greatly reduced and (2) the hydraulic roughness, or turbulence creating power, of the lining is considerably decreased.

The foregoing explanation was derived for an erect stem type of vegetation, yet it applies to kudzu, a prostrate vine, as well. A further examination of the diagrams shows that for each curve there is a range of rapid change in the value of *n*. This is the region where the stems and leaves on the vines are being bent downward and the tangled mass of vines is being straightened out by the force of the flowing water. The leveling out of the curve indicates that most of the vegetation has been flattened and "combed" out. After this stage is reached there is a further, but small, reduction in the values of the retardance coefficients.

[4]Cook, H. L. and Campbell, F. B. Characteristics of some meadow strip vegetations. Agr. Engr., vol. 20, no. 9 (September 1939).

TABLE 2. SUMMARY OF HYDRAULIC DATA

Experiment No.	Test No.	Flow, Q cfs	Velocity, V fps	Hydraulic radius, R, ft	Slope factor, S	Retardance coefficients Manning's n_m	Kutter's n_k
		First year — green (November, 1938)					
1	1	4.19	0.92	.616	.0346	.2182	.1438
	2	9.48	1.82	.668	.0288	.1059	.0776
	3	13.69	2.42	.706	.0324	.0875	.0665
	4	19.47	2.85	.806	.0328	.0816	.0640
	5	24.44	3.33	.836	.0322	.0710	.0570
		Second year — green (August, 1939)					
2	1	2.24	0.55	.581	.0323	.3392	.2112
	2	5.15	0.85	.750	.0331	.2616	.1781
	3	10.13	1.38	.854	.0346	.1797	.1307
	4	15.55	1.82	.932	.0354	.1461	.1106
	5	21.07	2.28	.976	.0326	.1156	.0905
	6	27.12	2.78	1.001	.0362	.1018	.0814
		Second year — dormant (February, 1940)					
3	1	1.17	0.72	.304	.0290	.1588	.0924
	2	2.98	1.25	.406	.0317	.1159	.0756
	3	4.92	1.72	.459	.0330	.0935	.0648
	4	10.20	2.82	.543	.0326	.0634	.0483
	5	15.18	3.35	.628	.0337	.0596	.0470
	6	20.34	3.72	.713	.0336	.0583	.0471
	7	25.19	4.18	.757	.0319	.0528	.0437

A comparison of Figs. 3 and 4 shows that Manning's *n* is considerably larger than Kutter's *n*. This may require some explanation. The fact is that the two are equal only for a hydraulic radius of 3.28 ft (one meter). For all other values they differ. For small and rough channels, Manning's *n* is larger than Kutter's *n*. Accordingly, the selection of a retardance coefficient will also depend on the flow formula being used.

Comments on Design. An outlet channel should be designed so that it will function properly over the entire range of flow conditions that will exist during a flood of the frequency selected for design purpose. This requires (1) that it have sufficient capacity to pass the design flood and (2) that the lining have sufficient protective ability to prevent failure during the flood period. Since the critical periods for these two conditions do not ordinarily occur at the same time, it is desirable to investigate the design for the several stages of growth or lining condition. This is well illustrated by an examination of the kudzu data.

The highest retardance coefficients occur in the summer when the lining has reached its densest growth. The most intense rains may also occur at this time. Thus the runoff may be the largest when the channel has its smallest capacity. This is one of the conditions to be investigated.

The lowest retardance coefficients occur in the late winter or early spring. This condition allows higher velocities to develop. At the same time the lining has its least protective ability. The disadvantage of this combination is offset by the fact that the rains at this time may be of a lower intensity. This is a second design condition.

It may be necessary to investigate other combinations of lining condition and rainfall intensity before the critical period for the channel lining can be determined. However, once this has been done, this same period can be used in designing similar channels of like lining in the same locality.

The data presented herein will help place the design of conservation channels on some rational basis such as suggested above.

H. C. Merritt to Be Tenth McCormick Medalist

THE Jury of Awards of the American Society of Agricultural Engineers has chosen, as the McCormick medalist for 1941, Harry C. Merritt. Thus in a century and a decade from invention of the reaper by Cyrus Hall McCormick does the memorial created in his honor and by his children devolve, as did the mantle of Elijah on the shoulders of Elisha, on another man whose lifework has made another milestone in the forward march of grain harvesting.

In contrast with the versatility and varied activities which have marked the careers of most of his preceding medalists, Mr. Merritt's rise to fame revolves mainly around his devotion to a single dominating idea and purpose, all the more distinguished because they were deemed impractical and uneconomic until discouragements and disparagements melted away in the cauldron of commercial success. One man against a doubting world, he demonstrated that major farm machines could be so reduced in size and cost as to be available to the mass market of small farms, with profit to producer and purchaser alike.

H. C. MERRITT

On August 28, 1881, at Vermont, Fulton County, Illinois, Harry C. Merritt was born the son of Henry and Jennie (Smith) Merritt. His education is briefly disposed of by mention that he "received a high school education and later attended business college." More significant, perhaps, in terms of character and ultimate achievement is the passing remark that he farmed until 1898. Thus, at an age when high school youths now are buying clothes and borrowing cars for the junior prom, Harry Merritt already had served his apprenticeship in the graduate school of toil.

Then, with all the maturity of 17 years, he became a farm machinery salesman. The biographer bothers with no such minor details as names of employers, but does mention that Harry not only sold but "experted" steam traction engines and threshing machines, and even fired a railroad locomotive. He did some dabbling with the earliest gasoline traction engines, harbingers of the tractors that were to come, and sold them for threshing in Illinois. Thus passed the years until 1911.

Then he became a branch manager for the Hart-Parr Company, by their own admission the founders of the tractor industry. For them he established and administered a branch house in Montana, purveying ponderous power that pulled prodigious plows to turn the virgin sod of the plains and drove the mammoth threshers of the wheat frontier. And here, among the cattle and sheep men, the pioneer farmers and adventurers, men who had turned their backs on the easy ways of the East, who spurned security and sought only space to fashion their own future with their own strength, was whittled out the philosophy of life that was to guide Harry Merritt.

Three years as branch manager, three more as sales manager, and then in 1919 Mr. Merritt forsook Hart-Parr to go on his own as a highway contractor in Kansas. On a project of considerable size he broke with precedent, ignored horses and mules for earth moving, and used crawler tractors instead. It came near breaking him, but it marked the beginning of the revolution in road building, and it seasoned the mettle of the man.

In 1923 he sold himself to the Allis-Chalmers Mfg. Co. and began to sell them his ideas. At that time this company was a rather small maker of tractors, a mere side line to its major lines of electrical and other big industrial machinery. Two years later he became manager of the tractor division of the company, and in 1937 assumed his present post as a vice-president.

Here he brought to bear the convictions, the force of character, and the breadth of understanding that began in his boyhood on the farm and continued through the following quarter century. He charted his course on the thesis that the economic ceiling of the mass market in tractors and similar farm machines was far below the pricing which then prevailed. He was bound to create machines small enough and low-priced enough that the great majority of small-acreage farmers could afford to buy and use them.

The record does not reveal that Harry Merritt has ever been much of a drawing-board engineer. Rather he has been the executive type, able to choose the right men and delegate to them technical problems—and to get those problems solved despite doubts from within and derision from without. He has not let details deter his advance on a broad front defined in terms of farm number and acreage, cropping systems and crop costs.

Harry Merritt is generally given credit for having put the farm tractor on rubber tires. It was in 1932, at the depth of the depression, and the whole tractor industry was in the doldrums. Some thought it was madness to suggest and try to sell tires that made tractors cost more. Mr. Merritt saw and sold the idea that rubber tires made farm power cost less. Gain in speed and reduction in rolling resistance enabled a 2-plow tractor to do a 3-plow job, with lower investment in tractor, plow, and every other implement and machine than a 3-plow tractor would involve.

As evidence of his vision, there is a legend that long before the rubber tires actually were available, Merritt was building tractors with a high gear utterly useless with steel wheels, hence locked out and left unmentioned until the arrival of rubber. Presently the entire tractor industry was offering rubber tires, with varying degrees of enthusiasm.

Merritt moved on to the next step in the popularization of mechanical power—the creation of smaller tractors, the economics of mass production, and pricing that spoke for itself. Again he set the pace for the industry, until the new and supposedly impractical size was outselling any of the older, accepted sizes.

Then came harvesting. The economy and efficiency of the combine method was recognized on every hand, demonstrated through decades of experience. But the combine business was deadlocked on the issues of farm acreage and combine investment. An inventor wandered from factory to factory, rebuffed by all the major makers of harvesting and threshing machinery as he sought to sell his design for a small, cheap combine. Harry Merritt bought it. The story of its evolution from the (Continued on page 32)

R. W. Trullinger to Be 1941 Deere Medalist

MANY men by their researches have added much to the world's store of science as it pertains to the soil. So, indeed, has the man now to be honored by award of the fourth John Deere gold medal by the American Society of Agricultural Engineers. What sets him apart from the others is the further fact and the further degree that he has made a science, an art, and a career of research as such. Possibly, as they planned their memorial, the descendants of John Deere may have envisioned such a man as "Bob" Trullinger when they set up the award for "Distinguished Achievement in the Application of Science and Art to the Soil."

R. W. TRULLINGER

Any appraisal of Mr. Trullinger's work is bound to bristle with the word "basic". The long-range objective of his life has been to direct all research toward fundamentals, to probe ever deeper into the secrets of the soil, yet always to select for study such matters as shall, in final and practical application, work to the weal of agriculture and of mankind. His genius is in sensing the span from pure science to applied agriculture and engineering.

Robert William Trullinger was born in the town of Farragut, Fremont County, Iowa, February 25, 1889. He was brought up on a farm, his father being a doctor of medicine and a pharmacist and also a part-time farmer. He attended graded schools at Farragut and the Ames, Iowa, high school. In 1910 he was graduated from Iowa State College as a bachelor of science in civil engineering, having majored in structural and hydraulic engineering. Subsequent graduate work in structural engineering, soil technology, and agricultural engineering resulted in the professional degree of agricultural engineer, granted in 1925.

During the period of June 1910 to March 1912, he engaged in railway bridge construction and municipal and county engineering, including the design and construction of highways and highway bridges, municipal paving, water supply, sewage disposal, and river straightening. He then became specialist in rural engineering in the Office of Experiment Stations, U. S. Department of Agriculture, responsible for supervision and preparation of the section of rural engineering in the *Experiment Station Record* and work as office engineer of the irrigation investigations division of the Office of Experiment Stations.

In two years his responsibilities were extended to include the sections of soils and fertilizers in the *Experiment Station Record*. At the same time he became responsible for administrative and technical examination of research projects in soils and fertilizers and agricultural engineering submitted by the state agricultural experiment stations for approval for prosecution under federal Hatch and Adams funds. This work involved close relationship with specialists in the state agricultural experiment stations charged with the organization, planning, and conduct of research.

In 1915 he was given responsibility for a section of illustrations and visual instruction under the editorial division of the States Relations Service. This involved organization and preparation of illustrated material, including illustrated lectures on technical subjects in agriculture for use by teachers and extension workers.

Early in 1917 he was called to active service in the U. S. Army and served until late in 1919 as research engineer officer, ranking as first lieutenant and captain. At the time of discharge he was in charge of research and development of all special type projectiles used as artillery ammunition by the Army, including gas shells, illuminating shells, armor piercing shells, smoke and incendiary shells, and the like.

Returning to his position in the Office of Experiment Stations, he devoted his time as a specialist to work in agricultural engineering, soils, and fertilizers, and in addition directed a portion of the administrative relationships between the Office and the state agricultural experiment stations. This involved not only organization, planning, and conduct of research in soils, fertilizers, and agricultural engineering, but the annual examination and reporting on the entire work and expenditures of a number of the state stations under the Hatch and Adams Acts, and later of the Purnell and Bankhead-Jones Acts.

With increasing responsibilities in these two definite lines he passed steadily through the positions of associate agricultural engineer, agricultural engineer, senior agricultural engineer, principal agricultural engineer, and principal experiment station administrator, to that of assistant chief of the Office of Experiment Stations, the position which he now holds. He was made assistant chief in August 1938 after having served over three years as acting chief.

In his present assignment, under the direction of the chief of the Office and of the director of research of the Department, he is in charge of that part of the work of the Office of Experiment Stations relating to the administration of the federal grant acts for research, and the coordination of the research of the Department bureaus with that of the state agricultural experiment stations.

Paradoxically, and perhaps proof of his rare talent, this man who drives so relentlessly the pursuit of abstract science and the generalship of a far-flung army of research, is mainly known and beloved for his genial, yet quiet, human qualities. Not with unseemly familiarity in his hour of formal recognition, but rather in reflection of the spirit which pervades hs myriad friendships he is here, as always, called "Bob." From among many tributes by many associates is this by H. B. Walker: "In the warmth and hospitality of his fireside, Bob reveals to guests his hopes and aspirations for agricultural engineering research. He tells of the limitless boundaries for service to mankind through scientific study and analysis, the extent of which is fixed only by the native abilities of unselfish men who are willing to prepare themselves adequately for these opportunities. He has been unselfish in passing on to others the benefits of his broad experience and scientific knowledge. He is a prodigious reader and an expert in preparing abstracts of scientific papers. Having a reading knowledge of many foreign languages, he has for many years assumed the tedious and perhaps unappreciated task of boiling down research findings in many fields and putting them together

in new patterns to stimulate the imagination and energy of station workers. Bob has many research 'graduates' in the various land-grant institutions—men who have been stimulated by his keen foresight, timely suggestions, and intimate desire to render unselfish service."

No space can here be spared, nor is it here necessary, to make any mention of Mr. Trullinger's well-nigh unnumerable papers, bulletins, and addresses, for a bibliography of only the major items runs to several typewritten pages. More important for our present purpose, and no doubt more weighty with the Jury of Awards, is something voiced by several associates, and thus by S. P. Lyle: "An administrator's or technical adviser's chief value is not in his public utterances or publications, but rather in a cool head and steady hand at the helm. Bob's fundamental knowledge of scientific problems and relationships, his judgment of the capability of workers with their available facilities, and his demonstrated ability to deal with the human and fiscal problems in a national program enlisting the cooperation of the foremost research workers and administrators in the land-grant colleges and universities, are sufficient evidence of his fitness for the award for which he has been selected."

As the older A.S.A.E. members know, Bob Trullinger has been a member of the Society since 1914, and an active member or chairman of the Research Committee for more than twenty years, not to mention many other technical and administrative committees through the same years. He was president of the Society in 1930-31. Other memberships include Tau Beta Pi, Phi Kappa Phi, Kappa Phi, Sigma Alpha Epsilon, and the Masons. He is an honorary member of the Western Drainage and Irrigation Research Association. He and his wife, nee Pearl Maude Jordan, have a daughter, Virginia.

Bob's colleagues generally join in the feeling, expressed by S. H. McCrory, that "this tribute to his work comes also as a recognition of many years of hard and faithful service in the field of agricultural research where there has been little opportunity for personal notice."

H. C. Merritt to Be Tenth McCormick Medalist

(Continued from page 30)

first crude form is an epic which need not be repeated now. Christened the All-Crop Harvester, it made its appearance on the market in 1935. Almost immediately it leaped to the forefront in number of units sold. Again Mr. Merritt had set the pace for an industry, and today all manufacturers sell more machines of that general size or class than all larger sizes combined.

No doubt all of these things would have come to pass without Harry Merritt, for progress will not wait forever for any one man. But by his vision, his courage, his judgment, and his supreme devotion to his determined purpose, Mr. Merritt has moved forward by many years the well-nigh complete mechanization of American agriculture. He has wiped out much of the differential in efficiency between the large and small farm, and has lightened the labors of farmers by the hundred thousand. What these things mean in preservation of the family system of farming and the American social order we can only vaguely surmise. But he has well won the 1941 award of the Cyrus Hall McCormick Medal for "Exceptional and Meritorious Engineering Achievement in Agriculture."

Mr. Merritt is not a member of the American Society of Agricultural Engineers, nor so far as is known of any scientific or technical body. He does, however, belong to the University Club of Milwaukee. His family consists of his wife, nee Nona Williams, whom he married in 1900, and three children—Henry, John, and Nona.

A Head Thresher for Plant Breeding Studies

(Continued from page 14)

grain dropped from the thresher to the trough where it slid by gravity to the pan. The pan used under the cylinder was also used under the trough. The air blast was regulated by tilting the fan and by the speed change of the fan.

The cost of this machine was about $50 complete, which could be reduced considerably by production methods. This machine may be built up by welding, thereby reducing its cost. For simplicity, the machines were built of machined parts bolted together, and could be built and adjusted by an average shop man.

Six of these machines have been built by the department of agricultural engineering at Kansas State College, and they have been used by the department of agronomy, the agricultural experiment station, and various agencies of the U. S. Department of Agriculture. During the harvest season of 1939, one of these machines, used in a preharvest wheat survey by the U.S.D.A. division of crop estimates, threshed more than 6500 samples. According to the agronomist in charge, the machine gave excellent service.

(EDITOR'S NOTE: Readers who wish to build a head thresher like the one described in this article, may obtain a bill of material by writing either to the author or to Secretary, A.S.A.E., St. Joseph, Michigan.)

A Simple Dynamometer

By M. A. Sharp

WE have a great many good mules in the South. We also have a great many arguments about whose mules are the best, and how they compare with horses. To help settle some of these arguments, we needed a dynamometer that would not cost much, could be understood by the average farmer, and could be transported easily.

The Tennessee agricultural experiment station has under way an experiment to determine the best type of mule for given conditions, and measurement of pulling power for short and long periods of time is necessary. There is also need for some attraction at county and other fairs that will be of special interest to farmers. The partial solution of these problems being rather simple, we made the necessary purchases at a junk yard and agricultural engineering students at the University of Tennessee made the dynamometer shown by the accompanying drawing.

Essentially it is very simple. A cable is wound around a drum and one end anchored to a post. The drum is made of two auto rear wheel assemblies with the hubs turned in and the wheels removed. As the team pulls the cart forward, the cable unwinds causing the drum to rotate. As the drum rotates, the axle operates an auto jack which tightens the brakes. As the brakes become tight, the pull against compression springs operates a recording lever on the dial. The maximum pull is recorded.

This dynamometer may be used to measure the pull of any farm implement, and continuous recording devices may be added at very little cost.

Author: Head, agricultural engineering department, University of Tennessee.

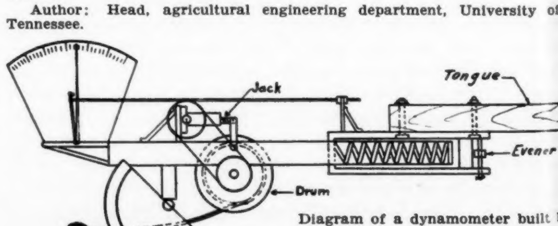


Diagram of a dynamometer built by agricultural engineering students at the University of Tennessee

NEWS

Nominations for 1941-42 Officers of A.S.A.E.

THE Nominating Committee of the American Society of Agricultural Engineers, consisting of F. R. Jones (chairman), A. W. Turner, and Roy Bainer, have placed in nomination the following members of the Society as candidates for the various offices to be filled in the next annual election of officers:

For President

GEO. W. KABLE, editor, "Electricity on the Farm"

For Councilor

C. E. FRUDDEN, executive engineer, tractor division, Allis-Chalmers Manufacturing Co.

D. A. MILLIGAN, equipment sales engineer, Cleveland Tractor Co.

For Councilor

RAY W. CARPENTER, head, department of agricultural engineering, University of Maryland

E. M. MERVINE, agricultural engineer, Bureau of Agricultural Chemistry and Engineering, U. S. Department of Agriculture

For Nominating Committee

E. D. ANDERSON, Republic Steel Co.

R. U. BLASINGAME, Pennsylvania State College

W. N. DANNER, University of Georgia

T. E. HIENTON, Purdue University

GEO. A. RIETZ, General Electric Co.

H. H. SUNDERLIN, Caterpillar Tractor Co.

The by-laws of the Society provide that by March 1 of each year the Secretary of the Society shall mail to each member entitled to vote a ballot stating the names of the candidates for the elective offices to be filled at the next election.

Southern Section Program

MEETING again in conjunction with the Association of Southern Agricultural Workers, the Southern Section of the American Society of Agricultural Engineers offers a program of five half-day sessions February 5, 6, and 7, at the Hotel Winecoff, Atlanta, Ga.

A joint session with the Soil Conservation Section of the A. S. A. W., Wednesday morning, February 5, will open the program. In the afternoon C. E. Seitz, chairman, will preside over a general session of the Southern Section. Farm structures will be featured Thursday morning, February 6, and farm power and machinery in the afternoon. Rural electrification interest will dominate the session Friday morning, February 7.

Discussions scheduled for the general session include "The Contribution of Farm Structures to the Progress of Southern Agriculture," by R. H. Driftmier; "The Contribution of Rural Electrification to the Progress of Southern Agriculture," by D. S. Weaver; "The Contribution of Farm Power and Machinery to the Progress of Southern Agriculture," by R. M. Merrill; and "The Contribution of Soil and Water Conservation to the Progress of Southern Agriculture," by A. Carnes.

Subjects and speakers for the farm structures session will be "New Approaches to Farm House Design, Construction, and Equipment," by J. W. Simons; "Grain Storage Problems in a Balanced Agriculture," by Ray Crow and LeRoy Reeves; "The Influence of Electric Heating Systems on Sweet Potato Storage House Construction," by Geo. H. Dunkelburg, with discussion by W. L. Green; "Some Practical Needs of Tobacco Housing Facilities in Southeastern United States," by J. M. Carr; and "Questions About Southern Farm Buildings," by W. V. Hukill. Frank B. Lanham will preside at this session.

Contributions to the farm power and machinery session are to include "Farm Mechanization with Special Reference to Southern Agriculture," by H. G. Davis, with discussion by J. L. Shepherd; "Southern Implement Dealers of the Past and Present," by R. L. Willis, with discussion by S. F. Maddox; "What Should the Farmer Expect from the Implement Dealer," by T. F. Purvis; "Engineering Phases of a Coordinated Extension Forage Crop Program," by J. T. Copeland; and "Equipment for Terrace Construction," by J. T. McAlister, discussed by Charles M. Sanders. C. V. Phagan, vice-president of the Section, will preside.

Features of the rural electrification session will be "A Perspective View of Rural Electrification," by S. P. Lyle; "A Summary of Barn Hay Drying Activities," by J. A. Schaller; "Georgia Studies of Barn Dried Hay," by W. E. Hudson; "Feeding Studies of Barn Dried versus Field Dried Hay," by C. E. Wylie; "Virginia Studies on Barn Hay Drying," by J. W. Weaver; "A Study of the Uses of Electricity on Two Hundred Low-Income Farms," by A. O. Brown; "The Cooperative Educational Program of the R. E. A. with Land Grant Institutions," by Oscar W. Meier; "Recent Developments and Applications of the Household Water Supply System," by G. E. Henderson; and "The Application of the Household Water Supply System for Garden Irrigation," by J. L. Calhoun.

A. S. A. E. members from outside of the Section area and other interested persons will be welcome at the meeting. Sessions are to be held in the main ballroom of the hotel.

A.S.A.E. Meetings Calendar

February 5-7, 1941—Southern Section Meeting, Winecoff Hotel, Atlanta, Ga.

February 7-8, 1941—Pacific Coast Section Meeting, Phoenix and Tucson, Ariz.

June 23-26, 1941—Annual Meeting, Knoxville, Tenn.

Agricultural Engineering Building Dedicated

A DEDICATION ceremony was held November 14, 1940, at the new Agricultural Engineering Building of the Pennsylvania State College. S. W. Fletcher, dean and director of the School of Agriculture, presided.

Program features included talks on "Farm Mechanization," by J. W. Cooper, president of the Pennsylvania Tractor and Implement Club; "Rural Electrification in Pennsylvania," by W. H. Wade, past president, Pennsylvania Electric Association; "College and Implement Industry Cooperation," by Grant Wright, publisher of "Eastern Dealer;" "Penn State A.S.A.E. Student Branch," by A. S. Marburger, president; and "Development of Agricultural Engineering at Penn State," by R. U. Blasingame, head of the department.

Facilities provided in the new building include 7200 sq ft of laboratory floor space, three classrooms with a total seating capacity of 185, student locker and shower rooms with 144 individual lockers, seven staff offices, and two agricultural engineering extension offices.

Agricultural engineering personnel at the College is listed on the program as including, on the teaching and research staff, R. U. Blasingame, A. W. Clyde, J. E. Nicholas, D. C. Sprague, E. W. Schroeder, and W. F. Ackerman; and on the extension staff, J. R. Haswell and V. S. Peterson.

American Standards Assn. Reports Progress

SOME 200 representatives of trade, technical, and governmental groups who hold membership in the American Standards Association met December 11, in New York, to hear Representative Hatton W. Sumners speak on "The Bearing of Standardization on the Cooperative Relations of Government and Industry"; and to discuss activities of the Association during the year just past.

Retiring President, Edmund A. Prentis, called attention to the fact that the American Standards Association during the year "has been called on to fill new needs and to fit into a somewhat changed industrial pattern." He was referring, of course, to the national defense program, which, with its need for coordination of defense-production standards, has affected many of the year's activities. For example, it has highlighted almost all standardization work in the mechanical field.

"The integration of the Government's purchasing program and industry's manufacturing program into a smooth flow of production is an enormous undertaking, and one in which standards play an important part." One of the problems of the coming year, Mr. Prentis said, would be to speed up work on undertakings most urgently needed for defense—for example work on screw threads, on bolts, nuts, and wrench openings; *(Continued on page 36)*

The FUEL FACTOR

-a basic consideration in future tractor design

SINCE the light-weight, rub tired high compression t tor was introduced about years ago, the number of trac on American farms has incre almost fifty per cent. A large of this increase comes fr smaller farms that heretofore h been unable to use mechani power economically and e ciently (Fig. 1). High comp sion engines, able to take adv tage of better fuels, give increa power and more efficient po without additional weight consequently are an impor factor in the design of comp flexible, inexpensive tracto Through the use of good ga line and high compression, fa ers are able to buy *more ho power at lower cost.*

Thus in tractor engines, as automobile, truck and aviat engines, each improvement fuel opens up new opportuni for increasing power and e ciency. In fact, the considerat of the "fuel factor" is today

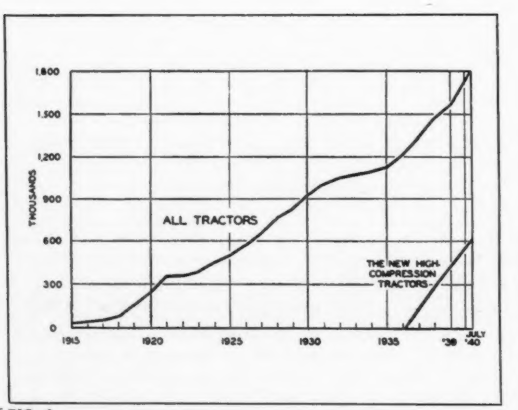


FIG. 1

THE RAPID INCREASE, starting in 1936, in the total number of tractors on farms in this country is due principally to the introduction of the small, high compression, automotive-type tractors. There are now 600,000 of these tractors in use, about one-third of the total number of all types. Data on total number of tractors is from the U. S. Dept. of Agriculture; that on the new type tractors from estimates made by manufacturers to National Petroleum News.

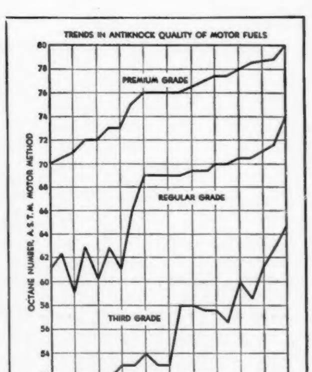


FIG. 2

OCTANE NUMBERS of automotive fuels have risen steadily over the past ten years. It is interesting to note that the regular gasoline being marketed today is superior in anti-knock quality to the premium gasoline of 1933.

of the most important elements in the long-range planning of all automotive equipment.

Designers of engines for tractors, as well as for automobiles and commercial vehicles, should keep the following fuel trends constantly in mind:

Higher anti-knock levels. The steady rise in anti-knock values is of prime importance because of its close relationship to permissible compression pressure. Farmers, as well as commercial vehicle operators, are quick to take advantage of the increased economy, performance and flexibility made available by higher anti-knock fuels (Fig. 2).

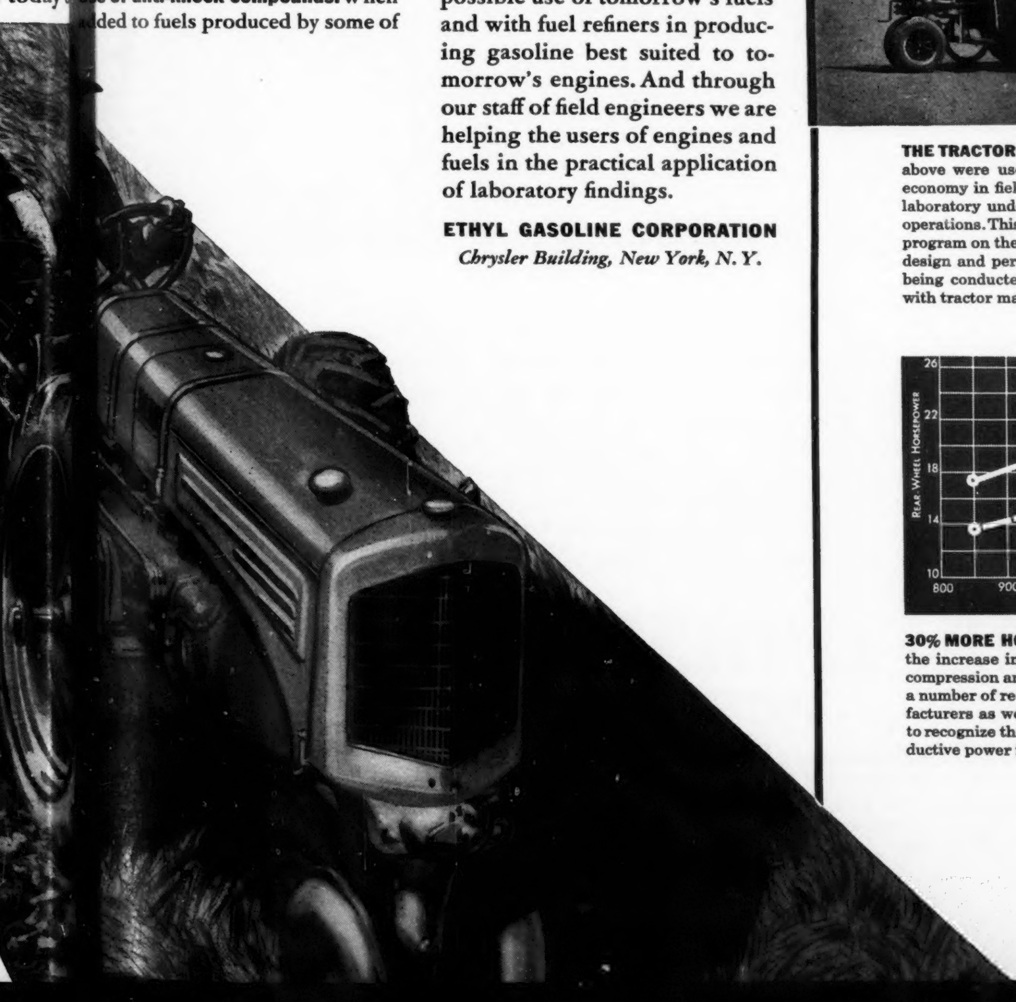
Improved fuel structure. For some time it has been known that motor fuels are made up of hundreds of individual hydrocarbons. These differ from one another in their properties; each has its own chemical structure, specific gravity, boiling point and anti-knock value. Refiners today can produce fuels containing higher proportions of the more desirable types of hydrocarbons.

Use of anti-knock compounds. When added to fuels produced by some of the new refining processes, tetraethyl lead gives an improvement far greater than when added to stocks now generally available. The increase in octane number resulting from the addition of tetraethyl lead will influence the refiner in his choice of refining processes, and it should be given equal consideration by the tractor and automotive engineer in broad plans for future engine development.

Each step toward more efficient tractors, automobiles, trucks, buses and aviation engines invariably involves the solution of new problems, problems not only of fuels and engine design, but of engine parts, materials and lubricants. We of the Ethyl Gasoline Corporation believe that these problems can best be solved by coordinated, intensive research on the part of the tractor, automotive and petroleum industries.

At our laboratories in Detroit and San Bernardino we are actively cooperating with engine designers in making the best possible use of tomorrow's fuels and with fuel refiners in producing gasoline best suited to tomorrow's engines. And through our staff of field engineers we are helping the users of engines and fuels in the practical application of laboratory findings.

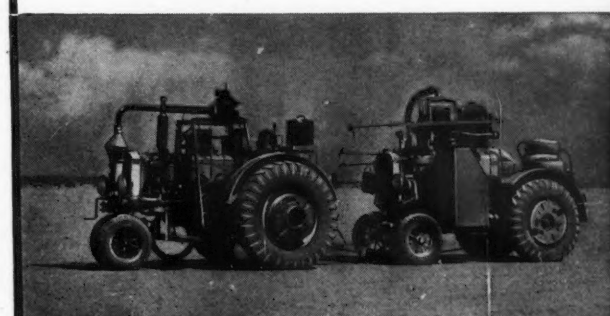
ETHYL GASOLINE CORPORATION
Chrysler Building, New York, N. Y.



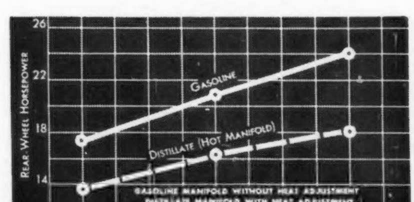
MAKING TRANSPORTATION BETTER AND MORE ECONOMICAL THROUGH RESEARCH

Here are some of the lines of research in which the Ethyl Research Laboratories are now engaged:

Application of higher compression ratios to commercial vehicles and farm tractors for more efficient utilization of today's improved fuels ★ The development of super compression engines for the utilization of tomorrow's fuels of 90 to 100 octane number ★ Supercharging of passenger and commercial vehicle engines ★ Effect of volatility on anti-knock value ★ Effects of sulfur ★ Anti-knock tests on new fuels ★ Study of the relation of lubrication to fuel and engine developments ★ Pre-ignition ★ Studies of improved ceramics and metal alloys ★ Instrumentation.



THE TRACTORS with their instrumentation pictured above were used to measure horsepower and fuel economy in field tests made at our San Bernardino laboratory under conditions simulating actual farm operations. This work is part of an extensive research program on the relation of fuel characteristics to the design and performance of tractor engines which is being conducted in our laboratories in cooperation with tractor manufacturers and fuel refiners.



30% MORE HORSEPOWER. The above chart shows the increase in horsepower obtained by using high compression and a good grade of regular gasoline in a number of recent tractor tests. Farm tractor manufacturers as well as tractor owners have been quick to recognize the fact that more power gives more productive power farming.

American Standards Association Reports Progress

(Continued from page 33)

on machine pins; on wire and sheet metal gages; on fit of machine parts; and on some of the safety codes which are needed to protect the inexperienced labor that is being turned into defense production. The defense program, Mr. Prentis pointed out, is requiring activities in new fields, the expansion of existing work, and increased activity on many of the projects now underway.

Turning to the technical work, R. P. Anderson, chairman of the Standards Council, reported that during the year the Association has approved 73 standards. Among them are many specifictions for materials, some important safety codes, a dozen gas appliance standards, many standards in the mechanical and electrical fields.

Probably the most important standard in the mechanical field to be approved during the year is one on twist drills. Also approved during the year are several standards for cast-iron pipe, for steel pipe flanges and fittings, and a new standard for spur gearing.

One new standard of interest to everyone who deals with figures, is the "American Standard Rules for Rounding Off Numerical Values." It sets forth a simple and effective method of rounding numbers, pointing out a common error in the practice followed by most of our schools.

One of the most active projects this year has been in the field of photography. A committee representing manufacturers, dealers, consumers, governmental groups, and others interested in photographic supplies and equipment has been working on a group of important photographic standards. First completed standard in this field is a proposed method for determining the photographic speed of roll film, film packs, and miniature camera films. This standard, which covers one of the most discussed and controversial subjects in the field of photography and is one of interest to all amateurs, is now being published for a year's trial and criticism. Several other standards in the field, one for printing equipment, one for projection equipment, one for lantern slide projectors, and two for film pack dimensions, are nearly ready for publication.

Among the 73 standards approved this year is a series of 13 for gas appliances and accessories. Many of these are revisions of standards now in wide use. Some idea of the importance of this work may be gathered from the fact that fully 90 per cent of the gas appliances sold in this country today conform to American standards which have been developed by the gas operating and appliance industries through the American Standards Association. Due to the large-scale research, development, and testing work which has gone into this project, the AGA Laboratories estimate that more improvements have been made in domestic gas appliances in the past 10 years than in the previous 40. For example, in this ten-year period the thermal efficiency of gas range top burners has increased 50 per cent, and the efficiency of gas-fired hot water heaters 25 per cent.

During the year there has been important work in the electrical field. The National Electrical Code, successive revisions of which have been in use for nearly half a century, has been completely revised. The new edition provides many advantages in safeguarding life and property, at the same time recognizing important new developments in the application of electricity to heating and lighting. For example, it authorizes the use of new compounds which insulate safely at higher temperatures, and new methods of wiring which will enable home owners, as well as office and apartment house owners, to increase their electrical loads materially without adding to the number of circuits. Several thousand communities throughout the United States use this code as the basis of their regulations for the installation of electric wiring. The laws of these communities are so worded that as each new edition of the code is approved it automatically replaces the older edition, enabling the community to derive the greatest economy and protection from new materials and processes.

Personals

J. B. Kelley is senior author of Kentucky Extension Circular No. 351, on "Housing Farm Poultry."

Donald M. Kinch is now employed in the engineering department of the Oliver Farm Equipment Co., and is located at Charles City, Iowa.

J. D. Long is senior author of "Investigations in the Sulfuring of Fruits for Drying," published as Bulletin 636 of the California Agricultural Experiment Station.

Harold E. Pinches has prepared a Connecticut Extension Service mimeograph on "Safety in Farm Wiring."

Applicants for Membership

The following is a list of applicants for membership in the American Society of Agricultural Engineers received since the publication of the December issue of AGRICULTURAL ENGINEERING. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

C. S. Baker, president, Baker Mfg. Co., Evansville, Wis.

Howard F. Carnes, junior agricultural engineer, Bureau of Agricultural Chemistry and Engineering, U. S. Department of Agriculture. (Mail) 1905 Philomath Road, Corvallis, Ore.

Wansley H. Cox, research fellow, agricultural engineering department, Iowa State College, Ames, Iowa. (Mail) 2319 Knapp St.

Elmer R. Daniel, assistant extension agricultural engineer, Oklahoma A. & M. College, Stillwater, Okla. (Mail) R.R. 3.

Herman Finkel, 1868 S. Central Park Ave., Chicago, Ill.

Roland A. Glaze, architectural engineer, Weyerhaeuser Sales Co., 2091 First National Bank Bldg., St. Paul, Minn.

A. K. Mortin, experimental engineer, Frost & Wood Co., Ltd., Smiths Falls, Ont., Canada.

Arthur H. Schulz, county agent, Hettinger, N. D.

H. M. Thompson, irrigation engineer, Swift Current Experimental Station. (Mail) 676 University Drive, Saskatoon, Sask., Canada.

Student Branch News

GEORGIA

By J. E. Payne

OUR Branch met for the first time of the 1940-41 school year on October 14. President G. F. Daniel announced that the new constitution for the Branch would arrive soon and be posted in the club room.

The program of the first meeting included talks by R. T. Mims, R. H. Driftmier, and W. N. Danner, on the annual meeting of the A.S.A.E. at Penn State, and by W. D. Kenney, E. W. Daniel, and J. L. Shepherd on the Industry Seminar which they attended during the summer.

On Saturday, October 26, the Branch held its first dance of the year for its members and the students of the College of Agriculture. The dance was the first of the year to be put on by any student club, and will compare favorably with any of the dances given at the University.

The second meeting of the quarter was held on October 28. The new Constitution and By-Laws were read, approved, and adopted. President G. F. Daniel stated that he had received a letter from the president of the Tennessee Student Branch requesting a list of the awards and honors which are sponsored by our group. Dr. Paul W. Chapman, dean of the College of Agriculture, University of Georgia, then spoke to the Branch on the Southern Governor's Conference.

Initiation of twenty-three new members of our Branch was held November 9. These new members brought our total membership to 68. One of the main parts of the initiation to the Branch is an examination on its Constitution.

At the meeting on November 25, President G. F. Daniel appointed a committee to nominate candidates for the election of officers for next quarter. The program featured a picture by Allis-Chalmers, shown by their local dealer. Afterward he showed a short picture entitled the "Tractor Square Dance," which topped off the program for the evening.

IOWA

ALUMNI and other friends of the Iowa Student Branch received a holiday greetings booklet prepared and produced by the Branch.

Model Constitution Adopted

FORMAL adoption of the model constitution and by-laws for student branches of the American Society of Agricultural Engineers has recently been completed by the Branches at Texas A. and M. College, the University of Wisconsin, and University of Georgia.

Agricultural Engineering Digest

A review of current literature by R. W. TRULLINGER, assistant chief, Office of Experiment Stations, U. S. Department of Agriculture. Copies of publications reviewed may be procured only from the publishers at the addresses indicated.

DYNAMIC PROPERTIES OF SOILS AS APPLIED TO THE ELEMENTS OF IMPLEMENT DESIGN: DEVELOPMENT OF REDUCED-FRICTION SURFACES AND MATERIALS FOR EXPERIMENTAL PLOWS, *F. A. Kummer.* (Coop. Miss. Expt. Sta.) Alabama Sta. Rpt. 1938, pp. 7, 8. Comparative field tests on two types of bottom plows having, respectively, impregnated wooden surfaces and standard steel moldboards revealed that the impregnated wooden surfaces produced considerably better scouring than the steel moldboards. Tests of sliding friction between soil and wood or metal surfaces showed that under the same conditions considerably less force was required (in some cases 50 per cent less) to move the impregnated wooden sliders over the soil than was required to pull the steel sliders.

40-DAY LOSS: 14 TONS SOIL PER ACRE, *T. N. Jones.* (Coop. U.S.D.A.) Miss. Farm Res. [Mississippi Sta. (State College)], 3 (1940), No. 9, p. 2, fig. 1. The author presents a brief report of the effects of rainfalls of from 0.11 to 8.58 in on erosion-measurement plats ranging in slope from 2.5 to 12.5 per cent, the soil being Houston clay, the crop cotton in contour rows. The proportion of the rainfall lost as runoff ranged for the 40-day period from 0 to 81 per cent. The total soil loss from the 12.5 per cent slope was nearly 14.82 tons, from the 7.5 per cent slope 14.14 tons, and from the 10 per cent slope nearly 11.78 tons. It is pointed out that the rains of the largest total quantity do not always cause the greatest soil and water losses, the determining factors being apparently the rainfall intensity and the moisture content of the soil at the beginning of the rain.

WATER AND SOIL CONSERVATION EXPERIMENTS AT SPUR, TEXAS, *R. E. Dickson, B. C. Langley, and C. E. Fisher.* (Coop. U.S.D.A.). Texas Sta. (College Station) Bul. 587 (1940), pp. 67, figs. 36. This bulletin reports upon work on Miles, Abilene, and associated soils, subject to an average annual rainfall of between 20 and 21 in (extreme variation, from 11.09 to 38.08 in), of which annual precipitation about 80 per cent falls during the growing season.

Level terraces having ends open were found to be much more efficient in conserving water than terraces with 3-in slope per 100 ft along the terrace, and to cause an appreciable increase in crop yields. Level terraces with ends closed so as to hold all the water that falls gave an average increase in crop returns for 12 yr of $6.21 per acre per year over those obtained by the old conventional practice of running the rows with the slope. By diverting the runoff water from a 1,200-acre watershed onto a 120-acre sirup pan terrace system the water for use by crops on the system has been increased approximately 16 per cent, and crop yields have shown a marked increase.

Seventy per cent of the rainfall during 1937, 1938, and 1939 was evaporated from fallowed plats of Abilene clay loam soil. Tillage and cropping practices that may increase the rate and amount of penetration of water are being studied with a view to increasing the amount of available water by decreasing evaporational opportunities. Solid contour listing of native grass pastures resulted in a deeper penetration of soil moisture, an increase in available moisture, and a threefold increase in forage production. A close relationship exists between the available water in the soil at planting time and the yield of lint cotton. Seasonal rainfall, although a highly significant factor in determining crop yields, apparently is of less importance than moisture stored in the soil prior to planting time.

REPAIRING FARM MACHINERY, *I. G. Morrison.* Danville, Ill., Interstate, 1940, pp. [16]+181, figs. [133]. The author has assembled instructions and methods for repair of some of the more generally representative farm machines. The book is designed primarily to be of use in the training of teachers of vocational agriculture, as a reference book for students in this field, and as a manual for farmers in farm-machinery repair. The repairing of mowers and of grain binders is dealt with in much detail, attention being called to the fact that many of the jobs on the mowing machine are applicable to other farm machines, especially to the cutting mechanism of binders and combines. Between one-third and one-half of the book is devoted to these two machines. Less detailed instructions for the repair and adjustment of the walking plow, wheeled plow, disk harrow, spike-tooth harrow, spring-tooth harrow, cultivator, corn planter, grain drill, side-delivery rake, and corn binder are given, together with a short section on the painting of farm machinery. *(Continued on page 40)*

Agricultural Engineering Digest

(Continued from page 38)

THE EFFECT OF POSITION IN THE BIN AND TEMPERATURE DIFFERENTIALS ON LOSS OF WEIGHT OF POTATOES IN STORAGE. New Hampshire Sta. (Durham) Bul. 319 (1940), p. 30. Data are reported from a study of three types of air intake for the ventilation of potato bins, by O. R. Butler and P. T. Blood.

Literature Received

1940 SUPPLEMENT TO 1939 BOOK OF A.S.T.M. STANDARDS

PART I, METALS. Cloth bound, xiii+479 pages, 6x9 in separately indexed. Covers ferrous and non-ferrous metals and general testing methods as to new standard and new tentative standard specifications, methods, recommended practices, and definitions adopted since publication of the 1939 volume. Discontinued standards are noted in a list of standards in numeric sequence. Includes 14 newly adopted and 26 replacement standards, and 15 newly adopted and 44 replacement tentative standards. Classified under structural and boiler steel, arc-welding electrodes, commercial bar steels, steel rail accessories, steel forgings, steel castings, steel tubes and pipe, steel pipe flanges and fittings, steel bolting materials, corrosion-resisting steels, zinc-coated steel and iron articles, electro-deposited coatings, iron castings, magnetic properties, general methods of testing ferrous metals, aluminum and aluminum alloys, magnesium and magnesium alloys, copper and copper-alloy wire and cable, copper and copper-alloy castings, copper and copper-alloy bars, rods, and shapes, copper and copper-alloy pipe and tubes, copper and copper-alloy sheet, strip, and wire, lead, solder metal, die castings, electrical-heating and electrical resistance alloys, and general testing methods. American Society for Testing Materials, 260 S. Broad St., Philadelphia, Pa. Prices scheduled with variations according to membership, binding, and parts ordered.

SOIL PHYSICS, by L. D. Baver. Cloth bound, xi+370 pages, 6x9 in, 70 illustrations, 54 tables. Indexed by subjects and reference authors. A text for graduate and advanced undergraduate classes, explaining the author's concepts of fundamental aspects of soil physics and their practical application. Where experimental evidence is not conclusive on any specific property, the author presents and discusses other leading viewpoints in addition to his own. Chapter headings cover introduction, mechanical composition of soils, physical characteristics of soil colloids, soil consistency, soil structure, soil water, soil air, soil temperature, physical properties of soil and tillage, and physical properties of soil in relation to runoff and erosion. John Wiley and Sons, Inc. (New York), $4.00

EMPLOYMENT BULLETIN

The American Society of Agricultural Engineers conducts an employment service especially for the benefit of its members. Only Society members in good standing may insert notices under "Positions Wanted," or apply for positions under "Positions Open." Both non-members and members seeking to fill positions, for which ASAE members are qualified, are privileged to insert notices under "Positions Open," and to be referred to members listed under "Positions Wanted." Any notice in this bulletin will be inserted once and will thereafter be discontinued, unless additional insertions are requested. There is no charge for notices pub... ASAE, St. Joseph, Michigan.

POSITIONS WANTED

AGRICULTURAL ENGINEER with B. Sc. degree from the University of Minnesota, six months' experience in farm machinery, and one school year as instructor in farm motors, desires position as instructor of farm mechanics or position in maintenance, care, and repair of motors. PW-330

AGRICULTURAL ENGINEER with M. S. degree from Cornell University (1923) and with teaching, industrial, farm building design, and rural electrification experience, desires position where his originality and inventive ability may be used. Can offer manufacturer a new idea for impeller-propeller, electric fencer, small automatic egg cleaner, or electric soil sterilizer. Preferred location central or eastern New York state. PW-331

AGRICULTURAL ENGINEER with B. Sc. degree from University of Illinois, 1937, and three years' experience in rural electrification with a public utility in Central Illinois, desires similar position with a utility or REA having an aggressive rural electrification program. Present position has included experience in contacting farmers, securing right-of-way easements, preparing estimates, designing lines, and promoting the use of electricity. Age 26. Health excellent. No bad habits. Married. Rural background. PW-332